FOOD TECHNOLOGY

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IN THIS ISSUE

Scientific and Technical Progress in Yeast and Bread Production / *211*

Effect of Drying Conditions on Moisture Retention and Density of Dehydrated Peas / *219*

Factors Affecting the Texture of Rehydrated Potato Granules / *223*

Effect of Processing Conditions on the Viscosity of Tomato Juice / *228*

Feasibility of Using Plastic Film Packages for Heat Processed Foods / *236*

Physical Properties of Cake as Affected by Method of Butter Manufacture and Addition of an Emulsifying Agent / *241*

Problems in Developing and Administering a State Food and Drug Regulatory Program / *247*

Pen Surfaces and Odour Development in Trawler Fish Holds / *251*

A Comparison of Through-Air-Flow and Cross-Air-Flow Methods for the Initial Dehydration of Sweet Corn / *254*

Improvements Required in the Freezing, Storage and Distribution of Frozen Foods / *259*

Microscopic Structure of Frozen Cake Batters / *261*

A Study of Color Change in Stored Apple Juice Concentrates / *264*

Effect of Storage Temperature on Quality of Canned Grapefruit Sections / *268*

Affairs of the Institute / *2*

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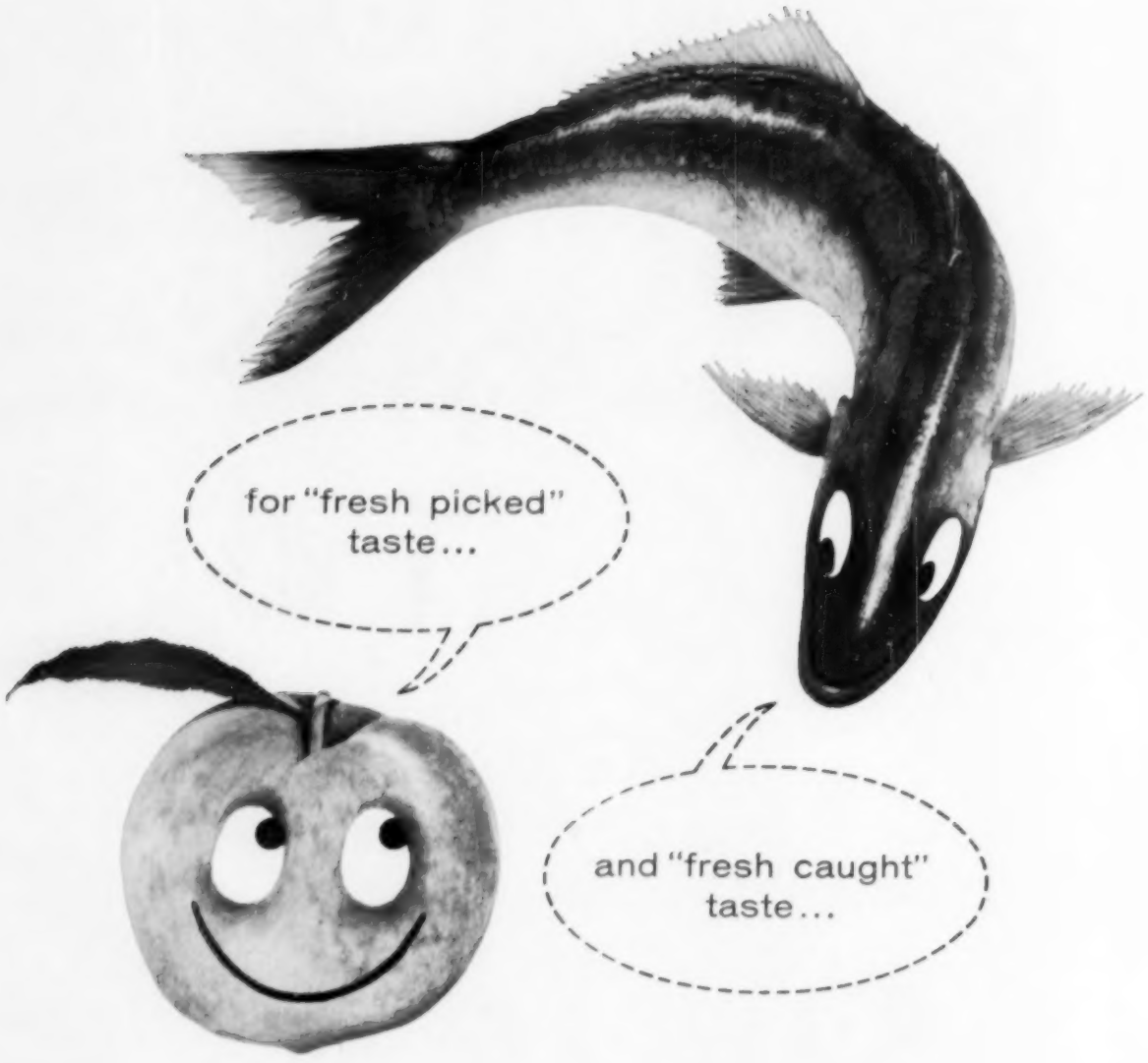

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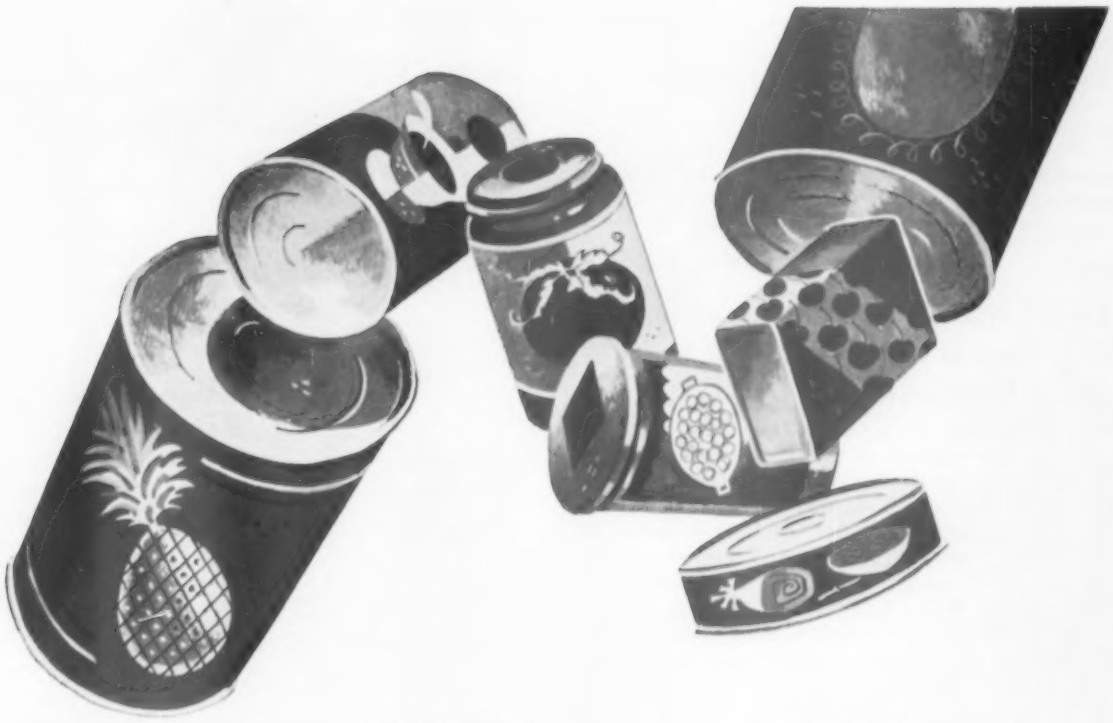

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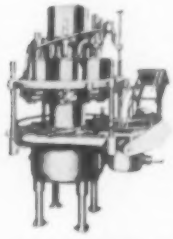

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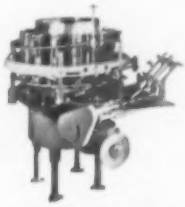

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Affairs of the Institute

Appert Award to Dr. C. G. King
Regional News
Personnel
Books
Selected Abstracts
Newly Elected Members
Annual Meeting Bulletin Board
Food Industry Topics
Future Meetings

Dr. Charles Glen King Named 1955 Appert Award Medalist by Chicago Section of IFT

For distinguished work on vitamins, enzymes, synthetic fats, and other food constituents, for furthering scientific interest in biochemistry, sanitation and human nutrition, and for his leadership in nutrition and several of the other sciences on which food technology depends, Dr. Charles Glen King, Scientific Director, The Nutrition Foundation, Inc. has been selected as the 1955 Nicholas Appert medalist. The presentation will be made at the Appert Award Banquet to be held during the Fifteenth Annual Meeting of the Institute of Food Technologists, Columbus, Ohio, June 12-16, 1955. The award, made annually by the Chicago Section of IFT to an eminent scientist for contributions to the field of food technology, commemorates the work of Nicolas Appert "father of the world's canning and bottling business." Appert (1752-1841) won from the French government in 1809 the first food technology prize on record—12,000 francs—for his epochal invention that launched a great industry.

Charles Glen King, Ph.D. (University of Pittsburgh) served early in his career on the faculty of the University of Pittsburgh and, later, on the Columbia University faculty as professor of chemistry. His long-time interest in nutrition, a product of his chemical studies, culminated in his appointment to the Scientific Directorship of the Nutrition Foundation, Inc. In that capacity he has furnished for many years not only the leadership for an extensive program of nutrition research but also counsel and guidance for various educational projects devoted to bettering the nutritional status of our own and other national populations. He is, for one example, special consultant to the United Nations Children's Fund.

As another man might be called civic minded, Dr. King could well be called "national minded." He has given of his talents and energies to the American Chemical Society (former chairman, Biological Division), the American Public Health Association (former chairman, Food and Nutrition Division) the National Research Council (where, among other committee memberships, he has served as a member of the Executive Committee of the Food and Nutrition Board), the National Red Cross (member Executive Commmittee) and the Institute of Food Technologists (ex-Secretary). He is currently President of the American Society of Biological Chemists.

When Dr. King, most recent of the Appert medalists, is presented the Appert Awawrd in Columbus, Ohio, next June, he will be accepted into a distinguished company of past awardees. The list includes Dr. Samuel C. Prescott, William V. Cruess, Olin Ball, C. A. Elvehjem, Roy C. Newton, A. E. Stevenson, A. J. Lorenz, E. M. Chase, C. E. Frey, and Victor Conquest—and several awardees, since deceased, Charles A. Browne, A. W. Betting, and Thomas M. Rector. All of these names, famous in the history of food research and technology, have added luster to the medal that bears the name of the founder of the House of Appert.

Regional Section News

NEW YORK SECTION

Teamwork by Technologist and Broker Helps Food Manufacturer. Food brokers and food technologists should work in closer cooperation. Channeling the right kind of food into the right market at the right time is their common interest and objective. These are key points made at the March 16 meeting of the New York Section of the Institute of Food Technologists by Mr. E. N. Reusswig of Lestrade Bros., New York.

Serving in an advisory capacity, the broker can help to eliminate much misdirected research, and production effort and expense, on items with potential marketing weaknesses, the speaker said. From the broker's viewpoint, there are at least five points that the technologist should consider in measuring a product for the public's purse: (1) Quality, (2) Convenience, (3) Availability, (4) Economy, and (5) Versatility.

In launching new products or improving old ones, use of these five yardsticks would establish a worthwhile liaison between the manufacturer, his technologists, and the food broker.

In stressing the need for maintaining standards, Mr. Reusswig pointed out that the consumer is quick to recognize when a product's quality slips. And a valuable source of consumer preference data should be the 1800 brokerage firms scattered in strategic markets throughout the U. S., Canada, and Mexico.

Today, the technologist who perfects items with multiple uses is ahead in his field, according to the broker. The merchandising appeal of a single product that can supplant several old ones is a boon to the grocer's displ[illegible] problem.

Technologists Honor Burton and Get Good Advice. Food technologists must develop skill in communicating their ideas and information to others. That ability is essential to their personal success and to the advancement of their companies, their industry, and their profession.

This is the advice given to members of the New York Institute of Food Technologists, Inc., by Dr. Laurence V. Burton, as recipient of a certificate honoring him. The certificate was presented at the March 16 meeting, in recognition of Dr. Burton's outstanding contributions to the advancement of food technology.

The occasion of the presentation was Dr. Burton's March 1 retirement as executive director of Packaging Institute.

(Continued on page 6)

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INSIDE SCIENCE

The Vital Story of VITAMIN C

by Science Writer

What does vitamin C do for human beings?

Medical research shows that it is essential in maintaining healthy bony tissue and for the formation of collagen which is the main supportive protein of skin, tendon, bone, cartilage and connective tissue. It is needed for vascular function and tissue respiration and in promoting the healing of wounds. In lactating women it has great importance in providing the infant with a sufficient amount of ascorbic acid to prevent scurvy, a disease to which very young babies are susceptible.

Much evidence is available in medical reports to show that a lack of this vital nutritive element can result in impaired health. And in those cases of frank scurvy which still occur, ascorbic acid is the specific medication.

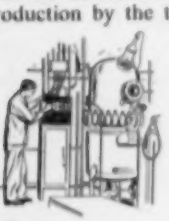
History. The history of vitamin C is fascinating. Scurvy, known for centuries, was once the most prevalent disease in Europe. It afflicted the Crusaders, decimated the crews of voyagers and armies, and plagued the colonists of the New World. In the 18th Century the antiscorbutic value of fresh vegetables and citrus fruits was recognized.

Isolation. It was not until 1918-25 that almost pure ascorbic acid was concentrated from the lemon by Zilva and its important properties and molecular composition established. In 1927 he concluded that this so-called "reducing factor" and the antiscorbutic principle were closely related. In 1928, Szent-Györgyi, who started investigations in 1921, isolated a strong reducing compound from adrenal glands, oranges, and cabbage and termed it "hexuronic acid."

Chemistry. The "reducing factor," "hexuronic acid," and vitamin C were all identified as the same in 1932 by various groups of workers. This was one year after C. G. King, by methods of organic chemistry and experimental physiology, established the chemical identification of vitamin C, thus fulfilling Budd's prediction of 90 years earlier that the antiscorbutic property of certain foods would ultimately be discovered to be a definite substance.

Synthesis. In 1933 Reichstein and his colleagues in Switzerland successfully synthesized ascorbic acid. Almost simultaneously in England Haworth and associates accomplished the same. The Reichstein synthesis formed the basis for large scale commercial production by the world-famous firm of Hoffmann-La Roche.

Production. Following these discoveries came the establishment of manufacturing operations so that today daily production by the tons is the rule. The figures are really staggering. The amount produced weekly in the U. S. A. averages over 15 tons, equivalent to that contained in over 200 million oranges. It is remarkable that ascorbic acid can be produced synthetically and sold for only about $16. per kilogram. One kilo is sufficient to supply 92 people for one year with the minimum daily requirements set by the U. S. Food and Drug Administration.



Vitamin C made by the Roche process is identical chemically and in biological activity with Nature's own product. Because vitamins can be manufactured at a much lower cost than if they were extracted from natural sources they are widely used in dietary supplements and pharmaceuticals. In fact, "New and Non-official Remedies," a publication of the American Medical Association for use by physicians states: "All pure ascorbic acid used in pharmaceutical products is prepared synthetically."

Ascorbic acid is present in many foods. Nature supplies some with lavish amounts and stints on others. In fact, wide variations* have been found in the vitamin C content in varieties of the same fruit.

Deficiencies. Many surveys have shown widespread vitamin C deficiencies in the population. Physicians may call these subclinical, but they are deficiencies nevertheless.

Because of these situations—natural variation and widespread deficiencies—diet experts believe that it is desirable and in the public interest to standardize the vitamin C content of processed fruit and vegetable juices by the addition of enough pure crystalline ascorbic acid to make them consistently dependable sources of this necessary food element. Some of these juices are: tomato, grape, orange, grapefruit, pineapple and apple.

Requirements. The U. S. Food & Drug Administration has set 30 milligrams as the adult minimum daily requirement of ascorbic acid. This daily intake is just about sufficient to prevent recognizable signs of vitamin C deficiencies although a subclinical or an unrecognized deficiency may exist. In view of this, the National Research Council has established 75 milligrams as the recommended daily male adult allowance and 70 mg. daily for female adults, which levels are supported by many controlled nutrition studies. However, the N. R. C. recommends 90 mg. daily for boys between 13 and 15, 100 mg. daily for boys between 16 and 20, and 150 mg. daily for lactating women.

This article is published in the interests of pharmaceutical manufacturers and food processors who make their good products better with essential, health-giving vitamin C. Reprints are freely available. Vitamin Division, Hoffmann-La Roche Inc., Nutley 10, New Jersey. In Canada: Hoffmann-La Roche Ltd., 286 St. Paul Street, West; Montreal, Quebec.

*The table shows minimum and maximum levels of ascorbic acid in commercially canned juices. All figures are in milligrams per 100 grams of juice. Data from U. S. Department of Agriculture.

	Min.	*Max.*
Apple juice	0.2	3.6
Grape juice	0.0	4.7
Grapefruit juice	10.0	49.0
Orange juice	9.7	70.0
Pineapple juice	5.4	18.0
Tomato Juice	2.5	32.0

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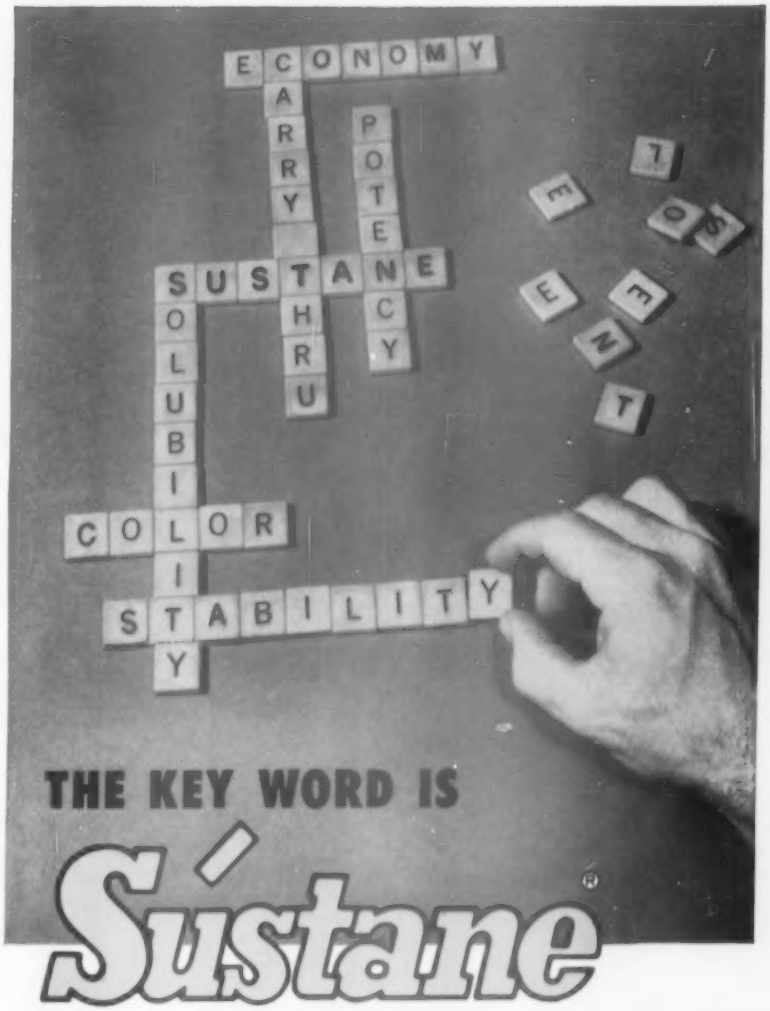

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REGIONAL SECTION NEWS

(Continued from page 2)

Dr. Burton has "carried the torch" for food technology for 20 years and more, it was pointed out in the presentation. He was one of the founders of the national Institute of Food Technologists and one of its pioneering presidents. He also helped to establish the New York section, and has been an active and outstanding member.

During his career, he served as a food technologist in the canning industry, as editor of Food Industries, and in operations connected with troop feeding in both world wars.

He took up painting as a hobby in the midst of his career, and is the author of the book "Week End Painter." He also operates a small suburban farm.

Although now "retired," Dr. Burton is working part time for Packaging Institute; and his plans for the future include consulting work.

NORTHEAST SECTION

One of the feature events of the year's program for the Northeast Section was the presentation of the General Foods Fellowship to Mr. Harold M. Rich, graduate student in the Department of Food Technology, Massachusetts Institute of Technology. In making the presentation to Mr. Rich at the December meeting of the Section, Mr. William M. Robbins, president of the General Foods Fund, called attention to the auspicious facts that the first General Foods Fellow, Harold M. Rich, was chosen from an institution prominent in the founding of IFT and that the founding father, Dr. Samuel Cate Prescott, was present at the award ceremony. Training in the basic sciences on which the betterment of food and human nutrition depend was emphasized as an important purpose of the General Foods Fellowship Awards program. Participating in the presentation were (left to right) Mr. Roy Walters (Director of Research, General Foods), Mrs. Harold M. Rich, Mr. William M. Robbins, Mr. Harold M. Rich, Dr. Samuel Cate Prescott, and Dr. Jean F. Caul, president of the Northeast Section.

On March 3rd, the Northeast Section had as its guest speaker Dr. E. F. Guba, Research Professor of Botany at the University of Massachusetts. Dr. Guba presented an excellent illustrated talk on the development of disease-resistant, commercial varieties of tomatoes, squash and cabbage and the effect of modern fungicides in increasing the yields of apples, peaches and other fruits.

Nominations for officers of the Section were submitted by the Nominating Committee. The slate for next year includes the following:

Chairman: E. E. Lockhart
Vice-Chairman: W. L. Cummings
Secretary: E. R. Barron
Treasurer: A. S. Levine
National Councilor: L. B. Sjostrom
Section Councilors: E. E. Anderson, J. H. Moriarty

Dr. J. Avery Dunn discussed the mid-winter meeting of the Executive Committee of the Council.

An item of note is that the Northeast Section is preparing a directory of members to be issued in the near future.

MISSOURI VALLEY SECTION

The second meeting of the Missouri Valley Association of Food Technologists was held Friday evening, Feb. 25, 1955, at Hotel Fontenelle, Omaha. A dinner for 30 people was held preceding the meeting. The group heard a short talk by Mr. Chuck Gregory, Loading Engineer for the Union Pacific Railroad, who discussed methods for elimination of canned goods damage in transit by new loading designs.

An announcement was made by the chairman that Col. Lawrence, Executive Secretary of the IFT, had expressed the willingness of either himself or Dr. L. E. Clifcorn, the National President-elect, to be present at a meeting soon. Denis Robinson suggested that the organization be listed with the Omaha Chamber of Commerce and the chairman directed the secretary to take care of the matter. Dr. Robert E. Feeney, Chairman of the Department of Biochemistry and Nutrition at the University of Nebraska, expressed the willingness of the University to cooperate in the support of the Association. He mentioned the university's new Meat Laboratory, and cordially invited the group to hold one meeting a year at the Lincoln campus.

PHILADELPHIA SECTION

The regular monthly meeting of the Philadelphia Section was held on March 1 at Drexel Institute. The chairman announced that a plan is being studied whereby the Section would award student memberships in the IFT to students in Food Technology and related fields at colleges in the area served by our group.

Mr. Pouchain announced the candidates selected by the nominating committee for section officers for 1955-56. They are as follows:

Chairman: Louis W. Mahle
Vice-Chairman: Edwin C. Dryden
Secretary: Dr. Norman Kramer
Treasurer: William Knightly
Councilor: John R. Crimmins
Executive Committee (serve for 2 years): C. B. Darlington and Richard L. Mullan

Additional nominations may be made from the floor at the April meeting, at which time the election will be held.

Dr. James B. Allison, Director of the Bureau of Biological Research, Rutgers University, spoke to the section on "Dietary Proteins in Health and Disease." He discussed the balance of labile protein in the body,

(Continued on page 8)

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REGIONAL SECTION NEWS

(Continued from page 6)

and the factors which produce a disparity between nitrogen intake and nitrogen output. A negative nitrogen balance may be produced by starvation, disease or drugs. The nitrogen balance of the different organs and of the skeletal muscle may differ from that of the body as a whole. In the presenec of a tumor, the nitrogen balance of the whole body may be in equilibrium, while that of the tumor itself is positive and that of the rest of the body negative—that is, the tumor is robbing the body of its labile protein. Nitrogen balance may be controlled to some extent by the feeding of certain specific amino acids, such as methionine and glycine.

SOUTHERN CALIFORNIA SECTION

The meeting on St Patrick's eve upheld the tradition of the section. Dr. Sidney C. Rittenberg, Professor of Bacteriology at the University of Southern California, gave an erudite, interestingly presented talk on "Bacteria as They Affect the Canning Industry." He first defined the practical limits for any preservation treatment: that protection against botulism must be absolute without making quality and flavor non-competitive. This challenge may be approached by the use of (1) antibiotics, (2) dielectric heating, or (3) cold sterilization.

The use of antibiotics is handicapped by lack of knowledge of their *modus operandi*. Emulating the housefly in regard to D.D.T., 50 to 80% of staphlococci now completely defy penicillin—why? The theory that the antibiotic interferes with a basic enzyme process of the cell, even if known to be true, does not help much unless we know what enzyme is affected and how.

Dielectric heating has the tremendous advantage of heating simultaneously throughout the exposed mass of food, making lower temperatures effective as well as reducing the time of exposure; but the cost is high, special containers are required, and the effect on quality and flavor is somewhat unsatisfactory.

Sterilization without heat by means of cathode or X-rays or radioactive bombardment, has advantages in being continuous and applicable after packaging, but it does not inhibit enzymes, the color and flavor suffer, and the public will have to be convinced it is not imbibing any residual radioactivity. The poor flavor is known to be caused by the formation of free radicals, but here the food technologist is between a Scylla and a Charybdis, for anything that is done to eliminate free radicals also protects enzymes. Dr. Rittenberg thinks that here basic research is needed to elucidate how spores live and why they germinate. He also suggested a possible combination of some of the known techniques of food preservation.

GREAT LAKES SECTION

For the first time, the Section held a meeting in Canada; namely the Spring Meeting—1955, held April 15 at the William Pitt Hotel, Chatham, Ontario. Plant trips were arranged during the morning through the Chatham plants of the American Can Co. and the Hinde & Dauch Paper Box Co. Following the Directors' Luncheon Meeting held at the Hotel, the afternoon was devoted to the following technical program:

"A Study of Factors Contributing to Flat Sour Spoilage of Tomato Juice," by Dr. A. H. Jones and W. E. Ferguson, Division of Bacteriology, Department of Agriculture, Ottawa, Canada.

"Fruit Juice Viscosity as an Indication of Maturity," by Dr. J. H. L. Truscott, Laboratory Director, Horticulture Products Laboratory, Ontario Department of Agriculture, Vineland Station, Ontario.

"Flavors and Their Uses in Food Products," by Dr. V. J. Oswald, Ph.D., M.C.I.C. of the Ferminich Company of Canada, Toronto, Ontario.

"Corrugated Cardboard Packaging of Vacuum Cooled Fresh Produce," by Mr. Paul J. Bernard, Hinde & Dauch Paper Box Company, Toronto, Ontario.

Mr. Don Henshaw of the MacLaren Advertising Co., Toronto, Ont., a famous Canadian after-dinner speaker, addressed the Dinner Meeting. His topic was: "Kissin Kin."

AUSTRALIA NORTHERN SECTION

At the meeting held on March 1st, the Section was host for a return visit by the Dieticians' Association.

After a buffet dinner, the Chairman was pleased to introduce the two speakers for the evening, Professor and Mrs. J. C. Moyer of Geneva, New York.

Dr. Mary Mann Moyer spoke on American Food Habits, and described the range and types of processed foods available to the American consumer. She made several contrasts between food habits in the U. S. A. and Australia.

Professor Moyer described in outline the food work that is in progress at the State Experiment Station at Geneva, and in greater detail discussed the tomato processing studies, describing the pilot scale equipment that was designed for this work.

During the discussion that followed the talks, the subject swung round to the ethics of food advertising, and the visiting dieticians had much to say on the matter. They were not slow to bring forward many examples of unethical advertising, and complained of how this type of advertising hindered their work. They also appealed to the Food Technologists for more assistance in providing analyses of processed foods.

WESTERN NEW YORK SECTION

The Niagara Frontier Division of the Section met on March 21 in the ECF of Applied Arts and Science, Elmwood Ave., Buffalo, N. Y. After-dinner speaker was M. J. Thomas, Assistant Manager for Market Development, A. E. Staley Mfg. Co., who discussed "New Developments and New Products from Corn and Soybeans." He also described the general program established by the Staley organization to participate in the march toward greater business through science.

AMES SECTION

The Ames Section met in the Memorial Union, Iowa State College on October 22, 1954. At the luncheon Dr. L. E. Clifcorn, Director of Fundamental Research, Continental Can Company, gave a talk "Frontiers of

(Continued on page 10)

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REGIONAL SECTION NEWS

(Continued from page 8)

Nutrition." The afternoon meeting included talks by the following:

Dr. Genevieve Stearns, University of Iowa—"Role of Nutrition in Growth and Development."

Dr. Ralph T. Holman, University of Minnesota—"Essential Fatty Acid Deficiency and Metabolism."

Dr. Pearl Swanson, Iowa State College—"New Viewpoints in the Importance and Use of Proteins."

At the business meeting, the nominating committee reported the following officers had been elected for 1955:

Dr. Emerson Bird, Chairman. Iowa State College, Dairy Industry Department.

Mr. Richard T. Carey, Chairman-elect. Ocoma Foods, Omaha, Nebraska.

Dr. Frances Carlin, Secretary-Treasurer. Iowa State College, Food and Nutrition Department.

Members of the Executive Committee

Mr. John Meader, one-year term. Continental Can Company, Omaha, Nebraska.

Dr. Owen Cotterill, two-year term. Iowa State College, Poultry Husbandry Department.

The Section met again on March 4, 1955, in the Memorial Union at Iowa State College. The luncheon speaker was Mr. Frank Barta of the Matrix Engineering Corporation, Minneapolis, Minn. The afternoon program was devoted to the following talks on quality control:

"Quality Control in the Dairy Industry"—Robert Remaley, American Dry Milk Institute Inc., Chicago, Illinois.

"Quality Control in Fruit and Vegetable Industry"—E. W. Eikelberg, Fairmont Canning Co., Fairmont, Minn.

"Quality Control in the Meat Animal and Poultry Industries"—J. Kastelic and Owen Cotterill, Iowa State College.

Panel Discussion on Quality Control of Foods.

The Ames Section is planning to hold a meeting in Cedar Rapids this Spring and visit some of the food plants there.

MARYLAND SECTION

The Section held its March meeting on the 4th at the offices of Strasburger and Siegel, Baltimore. This was different from our prior events in that it was social in nature and not a dinner meeting. Sociability was stimulated, too, we might mention, by refreshments graciously provided to all fifty-three of us by our host.

As is our custom, Mr. Strasburger, Chairman, was presented with a gavel appropriately engraved with his name, in appreciation of his services, by Dr. A. H. Warth of Crown Cork & Seal Company. Mr. Strasburger thanked us and then explained how this social type of meeting could help us know each other, our problems and our respective duties. The result should be a better solution to our problems.

Mr. William Hart of John H. Dulany & Son Co., Inc. told us that the April 1st meeting will be addressed by Mr. W. Earl Graham, Manager of the Can Division of Crown Cork & Seal Company, who will speak on "Aerosol Packaging." The meeting will be in Baltimore at the Hotel Stafford at 6:30 P.M.

Our speaker for the evening on March 4th was Mr. J. Thomas Welch, who spoke on the "Miller Bill," a pesticide regulatory measure which sets up tolerances for recognized chemicals, their methods and times of applications, as well as methods for determination. This is a highly detailed measure and those interested should consult the *Federal Register*, Date October 20, 1954, Vol. 19, No. 204.

During the discussion, which became quite heated, it was evident that those experienced on the subject wanted some sort of control on the farmer as well as on the processor. Another advisable method generally agreed upon was early application of pesticides so that rains would reduce the residue to a safe figure by the time it reached the processor.

ERNEST H. WIEGAND AWARD

In honor of Ernest H. Wiegand, Professor Emeritus, Food Technology Department, Oregon State College, an annual award to an outstanding senior in Food Technology has been established. This award consists of an appropriate 5-year membership in the Institute of Food Technologists, a small gift, and the winner's name engraved on a plaque which is displayed in the Food Technology Building. The award is jointly sponsored by the Food Technology Club, the Ernest H. Wiegand Student Chapter of the IFT and the Oregon Section of the IFT.

The 1955 winner, Richard D. Sleeper, senior in Food Technology, Oregon State College, was chosen for the award this year on the basis of scholarship, activities, leadership and professional potential. Mr. Sleeper of Portland, Oregon will enter the Armed Services for several years upon graduation in June and then is planning to return to an active part in the food industry. The award winner was announced at the Agricultural School Banquet on February 23, 1955.

Professor Wiegand, former Head of the Food Technology Department, established the department in 1919. Through his work in this position he has developed better methods of dehydrating fruits and vegetables, brining cherries, canning fruits, utilizing waste and surplus foods, and pioneered studies in freezing fruits and vegetables. His mechanical recirculating dryer and his method of brining cherries have meant millions of dollars to food processors. He has given industry patents on a brine flotation method and equipment for quality grading of fruits. His development of the Seafoods Laboratory in Astoria, Oregon, has been a valuable addition to the research and teaching facilities of the Food Technology Department. He is still a leader in the food processing industry and is very active in consultation work.

PERSONNEL

DR. WILBERT A. HEYMAN, noted food chemist and President of the Heyman Process Corporation, Consulting Chemical Engineers, Brooklyn, New York, is leaving for a business trip around the world. Dr. Heyman, who is well known for his research and development of soluble coffee for the United States Army, carbonated coffee beverage for the Bottling Industry and coffee concentrate for the Syrup, Ice Cream and

(Continued on page 12)

THINGS TO COME...WITH

Glycerine

TASTY CREAM CANDIES . . . with longer shelf life

Candy makers have a problem when cream fillings develop disagreeable taste and odor after a few weeks on store shelves.

They've looked long and hard for a way to eliminate this spoilage which is caused by the formation of free fatty acids.

Researchers have tried to stop or slow down the reaction by adding chemical retardants. But taste and texture could not be sacrificed.

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REGIONAL SECTION NEWS

(Continued from page 10)

Vending and Candy Industries, is now designing and building a soluble coffee plant for Commonwealth Foods, Inc., in Manila. He expects to remain in Manila for three months to instruct factory personnel in his advanced methods of manufacturing soluble coffee.

Serving on the Civil Defense Foods Advisory Committee established by the National Academy of Sciences-National Research Council at the request of the Food and Drug Administration are a number of IFT members. The Committee will study the vulnerability of the food processing and warehousing industries to open attack or sabotage by biological, chemical, or radiological agents. Methods and facilities for sanitizing or decontaminating food plants, equipment, and products in a civil defense emergency are also of concern to the Committee.

Composed principally of food industries men, the members are serving without compensation as experts in their fields and not as representatives of their companies or institutions. Roy C. Newton, Vice President, Research, Swift and Company, Chicago, is chairman. Other members are: John S. Andrews, Director of Food Research, General Mills, Minneapolis; Robert R. Baldwin, Laboratory Director, General Foods, Hoboken; Gail M. Dack, Director, Food Research Institute, University of Chicago, Chicago; H. C. Diehl, Director, The Refrigeration Research Foundation, Colorado Springs; Arnold H. Johnson, President, National Dairy Research Laboratories, Oakdale, Long Island, N. Y.; Emil M. Mrak, Head, Department of Food Technology, University of California, Davis; and George W. Putnam, Vice President, Creamery Package Manufacturing Company, Chicago. Frank L. Gunderson, Technical Consultant, Washington, D. C., is serving as Executive Secretary of the Committee.

DR. PAUL J. KOLACHOV, who has been special advisor to the Armour Research Foundation's biochemistry section since 1951, has been named resident advisor to the first laboratory center devoted exclusively to technological research in Colombia. He and his wife departed for Bogota early in April.

The first of three phases in the agriculture, industry, and mining program will be an investigation of existing research installations to determine the direction of Colombian economic development. This will include technical personnel, equipment, and facilities that might be available to the new laboratories. Phase two will be concerned with organizing the structure of the laboratories and commencing the initial research and engineering work. Training of the staff in the fundamentals of practical technological research will comprise phase three of the program. The Colombian laboratories will be the fourth technological installation to be established under Armour Research Foundation's overseas program. The center, sponsored by Caja de Credito Agrario, Industrial y Minero de Colombia, will assist in creating in Colombia a greater awareness of the value of technological research and engineering and of the part that laboratories can play in assisting economic development.

The newly appointed resident advisor, Dr. Kolachov, is long experienced in the field of chemurgy, the science of the industrialization of agricultural products and by-products. He was director of research for Joseph E. Seagram & Sons, Louisville, Ky., from 1937 to 1951, where he worked in agricultural research, including crop improvement, development of dairy products, and processing of meat and meat by-products.

His experience in international research includes travel to Mexico, Argentina, Uruguay, Brazil, and Cuba to deliver lectures on agricultural technology for the American Chemical society. He was chosen U. S. delegate to the International Congress of Microbiology at Copenhagen in 1947 and Rio de Janeiro in 1950.

Books

ADVANCES IN PROTEIN CHEMISTRY. Vol. IX. Edited by M. L. Anson, K. Bailey, and J. T. Edsall. Academic Press, Inc., New York, N. Y., 542 pp., 1954. $10.50.

This excellent review series is indispensable to research workers and students in the fields of proteins and amino acids. Some of the chapters in Volume IX cover subjects fairly distantly removed from the field of food technology. Among these are "The Metabolism of Glycine" by Arnstein, "Resolution of Racemic α-Amino Acids" by Greenstein, "The Formation, Composition and Properties of the Keratins," by Ward and Lundgren, and "The Molecular Structure of Simple Substances Related to Proteins" by Mizushima.

On the other hand, since food technology is a very broad field, the information so carefully compiled in some of the other chapters will be greatly appreciated in certain specialized areas. "Naturally Occurring Trypsin Inhibitors" by Laskowski and Laskowski is an example, even though its scope is limited to a discussion of comparatively pure systems; the nutritional aspects are not reviewed. The trypsin inhibitors of many types of uncooked beans play an, as yet, incompletely understood role in their poor nutritional value.

Chalmers and Synge cover "The Digestion of Protein and Nitrogenous Compounds in Ruminants," a subject that is attracting increasing attention. The necessity of extending knowledge of the physiology, biochemistry and microbiology of ruminant digestion is stressed.

Cheesman and Davies survey "Physicochemical and Biological Aspects of Proteins at Interfaces" in a stimulating chapter that includes some unpublished observations. Applications of research observations in this field to the understanding of biological phenomena are suggested; the authors themselves point out that some sections of their review "may appear speculative to the point of imprudence."

Possibly of greatest usefulness will be Waugh's monumental review on "Protein-Protein Interactions." The title is defined by the author to include reactions of a protein with itself; hence, the chapter contains detailed discussions of the forces responsible for association, dissociation, denaturation, etc., as well as of specific protein-protein interactions such as antibody-antigen (350 references).

(Continued on page 14)

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The purpose of his activity goes back to the work of a famous biologist who found a substance which he named "neoretinene b." It reacts in a complex way with some complex substances in the retina of the eye to convert light energy into optic nerve signals. We then showed "neoretinene b" to be 2,4-di-cis-vitamin A aldehyde. This means vitamin A with twists at two specified points in the molecule. Our man here is preparing for further study a quantity of this specially twisted vitamin A, which the body ordinarily manufactures for seeing purposes out of regular vitamin A.

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leaders in research and production of vitamin A

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(Continued from page 12)

In general the editing is excellent. The book is well printed and bound. On page 429, substitute "geometry" for "geomerty."

HAROLD S. OLCOTT
Albany, California

CATALYSIS. VOLUME II. FUNDAMENTAL PRINCIPLES (Part 2). Paul H. Emmett, Editor. Reinhold, New York, 1955. 473 pages. $12.00.

The treatment started in the first volume of this series of the fundamental principles and theories of both heterogeneous and homogeneous catalysis is here continued. The classification of heterogeneous catalytic vapor phase reactions is treated by W. B. Innes; reaction rates and selectivity in catalyst pores, by Ahlborn Wheeler; the nature of catalytic surfaces and the nature of complexes on catalytist surfaces by Hugh M. Hulburt; general theories of heterogeneous catalysis by Ransom B. Parlin, Merrill B. Wallenstein, Brano J. Zwolinski and Henry Eyring; and catalysis in homogeneous reactions in a liquid phase is treated by Edward L. King. As in the earlier volume, separate author and subject indexes are also included.

ERNEST SONDHEIMER
Geneva, New York

STARCH AND ITS DERIVATIVES. J. A. Radley. John Wiley & Sons, New York, 1954. Volume I, xi + 510 pages, $10.00. Volume II, xi + 465 pages. $10.00.

This is the third edition of "Starch and Its Derivatives" and represents a truly comprehensive treatment of the subject up to about 1948. The 975 pages in the two volumes are packed with a great diversity of information of value to anyone interested in the field. It is well written and edited and has good continuity.

It is to be regretted that there was a considerable time lapse between preparation of the manuscripts and publication. For example, it is only infrequently that reference is found to the research conducted during the past six years. In some instances an attempt has been made to correct this by "last minute" addition or revision but not too successfully. Notwithstanding, it is an excellent review up to this point, and a very welcome addition to the library.

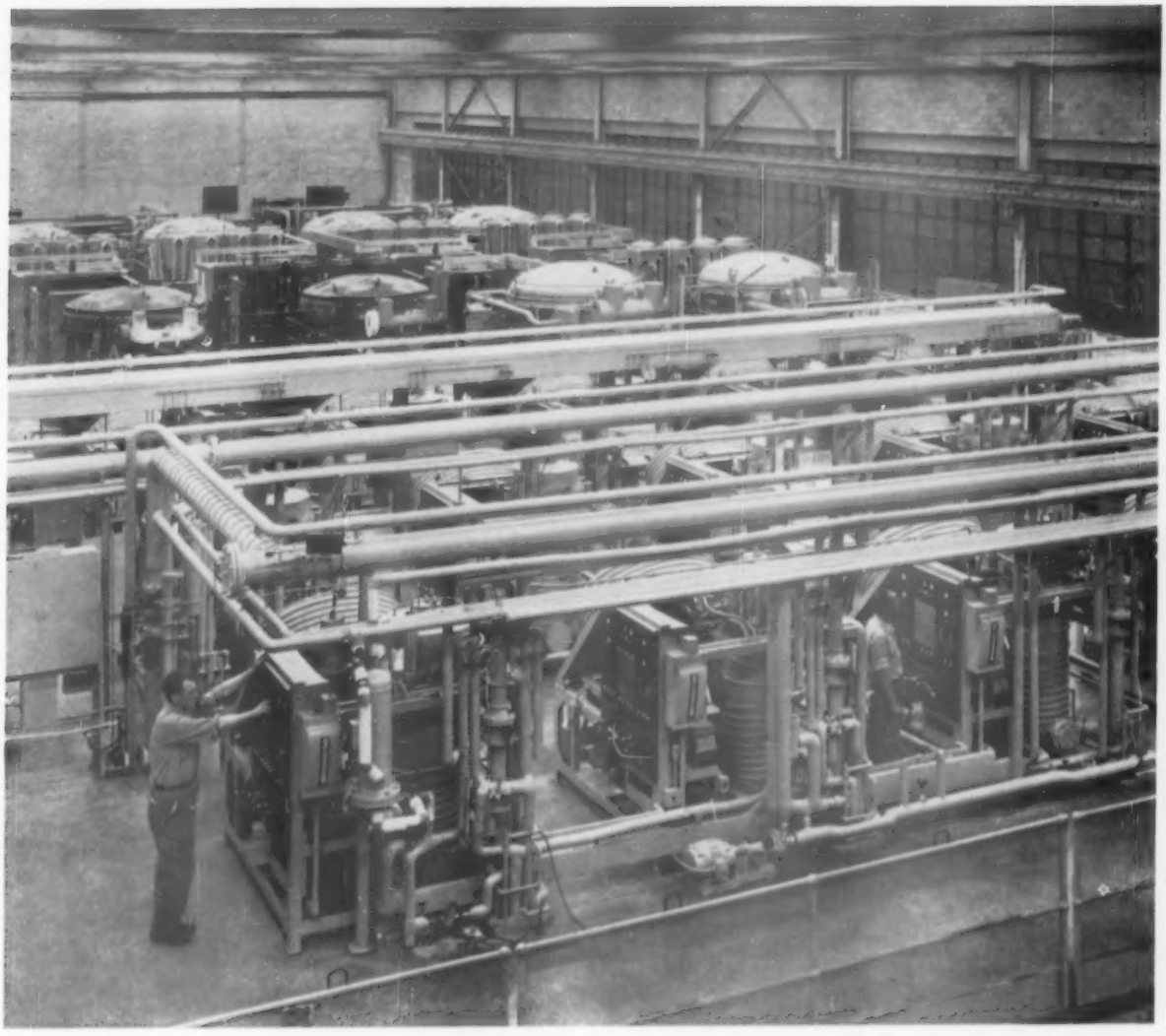
Volume I is divided into two parts. The first of these is made up of some 365 pages on the structure and reactions of starch. Part of this was contributed by J. A. Radley and it includes excellent chapters by notable authorities in the field. The treatment by S. Peat of "The Biological Function of Starch" serves as an excellent introduction. The following chapters have not only been ably edited by Professor Radley but also supplemented by much material from his own hand.

It is very pleasing to see the chapter by T. J. Schoch on "Starch Fractions." This is probably the most comprehensive presentation that Dr. Schoch has made of this subject and is adequately supplemented with 437 references.

The chapter on "Waxy Cereals," by Hixon and Brimhall, is a very welcome feature. It is a complete treatment that will be much appreciated by the reader.

Part II of the first volume is devoted to J. A. Radley's presentation of the "Amylases and Their Action on

(Continued on page 16)



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BOOKS

(Continued from page 14)

Starch." These seven chapters provide a complete treatment and bring the subject quite well "up to date." They include the classical concepts as supplemented by the more recent reports on new enzymes, enzymatic starch synthesis, and so forth.

Volume II of the work is devoted to industrial concepts and to analyses. Part I has excellent chapters by the Editor, by Ralph W. Kerr, and by L. A. Underkofler and the late Leo M. Christensen, all dealing with the "Manufacture of Starch and Starch Products."

Part II, on industrial applications, is mainly contributed by Professor Radley, but is well supplemented by an extensive review of the "Role of Starch in Bread Staling" by C. W. Bice and W. F. Geddes. Part III, on "Examination and Analysis of Starch and Starch Products," is again contributed principally by the Editor, but is supplemented by a comprehensive treatment of physical characterization by C. C. Kesler and W. C. Bechtel.

All in all, the two-volume work is of the quality one has come to expect from the competent writing and editorship of Prof. Radley. The reviewer would criticize it mainly for being not quite "up-to-date" and for some lack of critical presentation of the mass of accumulated data in the starch field. There is a tendency to lend equal weight to both old and new concepts, and to attribute "beliefs" to authors who may have revised their concepts markedly with later evidence. However, these are minor criticisms, and should not be taken as detraction from an excellent and major contribution.

ERIC KNEEN
Milwaukee, Wisconsin

NORTHWEST CANNERS ASSOCIATION ESTABLISHES SCHOLARSHIP AT OREGON STATE COLLEGE

An annual $100 scholarship in food technology has been established at Oregon State College by the Northwest Canners Association.

It will be presented each year to the outstanding junior student. The winner's name also will be inscribed on a plaque to be displayed permanently in the food technology building.

The award, association officials said, was established to encourage students to prepare for careers in the canning industry and "to give recognition to the Oregon State College food technology department for its outstanding contributions to canning industry progress through research and training programs."

C. R. Tulley, executive vice president, made the award announcement for the association.

Selection of the scholarship winner will be made by a committee representing students, faculty and the association.

Selection of the scholarship winner will be made by a committee representing students, faculty and the association. It will be based on scholarship, personality, and interest in food technology and the canning industry.

Selected Abstracts*

ANALYTICAL METHODS

Chlorogenic and caffeic acids in certain standard grades of U. S. type 12 tobacco.

WILKINSON, F. B., PHILLIPS, M., AND BACOT, A. M. *J. Assoc. Offic. Agr. Chemists, 37,* 1004-12 (1954).

A detailed procedure is presented for the quant. detn. of chlorogenic and caffeic acids in tobacco. The method is based on the fact that these acids can be oxidized quantitatively with an alk. hypoiodite soln.

A quantitative spectrographic method for the determination of tin, copper, iron, and lead in milk and milk products. The effect of storage on the concentration of these metals in evaporated milk.

GEHRKE, C. W., RUNYON, C. V., AND PICKETT, E. E. *J. Dairy Sci., 37,* 1401-8 (1954).

A rapid, reliable, and accurate spectrographic method has been developed for the quant. detn. of Sn, Cu, Fe and Pb in milk and evaporated milk. The analyses for these metals can be made simultaneously on a single sample. The precision of the method for the respective elements is from ±5 to ±8%.

The determination of monoglycerides and glycerin in mixtures.

KRUTY, M., SEGUR, J. B., AND MINER, C. S. *J. Am. Oil Chemists' Soc., 31,* 466-9 (1955).

The method is based upon oxidation of the sample with periodic acid. It is not necessary to sep. the 2 layers when the glycerin is extd. from the soln. of the samples. Precision of the titrations is improved because in the older methods the sample titration must equal at least 80% of the blank titration, but in the new method the sample titration can be very small and a correspondingly greater difference represents the monoglycerides or glycerin in the sample.

Gradient and rate aspects in paper chromatography.

ACKERMAN, B. J., AND CASSIDY, H. G. *Anal. Chem., 26,* 1874-6 (1954).

It was found that there is a mass gradient of liquid along the strip of paper up which liquid has risen, such that the thickness of the film decreases from the surface of the developer liquid to the front of the moving liquid. Data showing the thickness of this film are presented for 10 present-day papers, together with information about thickness of the papers, weight per unit area of the dry papers, and rate of rise of H_2O at 6 cm. ht. of rise. Correlations between structure of mols. and rate of rise of the liquid in paper are summarized from a study of 141 liquids. This information should be useful to chromatographers through its comparison of rates of flow of liquid and information on how much liquid is carried by the paper.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

Determination of amide nitrogen in collagen and other proteins.

MELLON, E. F., VIOLA, S. J., AND HOOVER, S. R. *J. Am. Leather Chemists' Assoc., 49,* 710-19 (1954).

An alk. hydrolysis method for the detn. of amide N is described. Values obtained by this method compare favorably with the literature values for a no. of proteins. A study of the amide N content of collagen obtained from the hides of identical twin cattle subjected to different nutritional levels shows that the amide value of the collagen is not affected in these expts. Some changes in amide values of collagen and gelatin due to processing are indicated.

Preparation and properties of a wool protein free of disulfide crosslinks.

O'DONNELL, I. J. *Textile Research J., 24,* 1058-63 (1954).

* These Selected Abstracts are made available to FOOD TECHNOLOGY through the cooperation of Dr. H. A. Campbell and his associates in the General Foods Corporation of New York, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

(Continued on page 18)

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SELECTED ABSTRACTS

(Continued from page 16)

Modified wools were prepd. in which all the disulfide bonds have been severed by reduction and alkylation under conditions not conducive to peptide-bond rupture. The possibility of introducing strongly lyophilic groups into the wool proteins by this method was investigated. The soly. and other properties of —S carboxamidomethyl wool and exts. from it were studied.

Studies on protein hydrolysis. II. The use of sulfurous acid for the control of humin formation and loss of tryptophan during acid hydrolysis.

PEDERSEN, J. W., AND BAKER, B. E. *J. Sci. Food Agr., 5,* 549-56 (1954).

The autoxidation of sulfurous acid was investigated with the aim of finding suitable conditions under which the acid might be used, either alone or in the presence of strong mineral acids, for the hydrolysis of proteins. Sulfurous acid alone or in combination with N-H_2SO_4 or N-HCl was found to be effective in the preservation of tryptophan during hydrolysis.

A general micromethod for the stepwise degradation of peptides.

FRAENKEL-CONRAT, H., AND HARRIS, J. I. *J. Am. Chem. Soc., 76,* 6058-62 (1954).

The phenyl isothiocyanate method for the stepwise degradation of peptides from the amino end has been adapted to a microscale and modified in such a manner as to be applicable to peptides contg. all natural amino acids, with the possible exception of cystine. This is achieved by following with the spectrophotometer the formation of the phenylthiohydantoins in strong aq. acid and thus avoiding unnecessary exposure to acid.

The fractionation of the non-protein nitrogen of grassland herbage.

FERGUSON, W. S., AND TERRY, R. A. *J. Sci. Food Agr., 5,* 515-24 (1954).

The total non-protein nitrogenous (NPN) fraction of oven-dried grassland herbage was examd. The NPN was obtained by extn. of dried herbage with boiling H_2O and it was fractionated as follows: (1) pptn. of part of the peptide-N with 75% alc., followed by (2) pptn. of purines with Ag sulfate (this treatment also pptd. some peptides), followed by (3) passage through a cation-exchange resin, which gave 3 main fractions.

Light scattering of isoionic bovine albumin.

DANDLIKER, W. B. *J. Am. Chem. Soc., 76,* 6036-9 (1954).

A comparative study of bovine plasma albumin in H_2O and in 0.15 *M* NaCl is presented. The technics described here can quite probably be used advantageously for studying salt-free solns. of other proteins which can be deionized by ion exchange or electrodialysis.

On the lipotropic action of protein.

HARPER, A. E., BENTON, D. A., WINJE, M. E., AND ELVEHJEM, C. A. *J. Biol. Chem., 209,* 171-7 (1954).

It is suggested that this secondary lipotropic effect of protein (the sparing of choline by methionine being the primary effect) is not a choline-sparing action but results from the provision of certain amino acids, deficiencies of which (with low casein diets, threonine deficiency) cause fat to accumulate in the liver. This effect is apparent only when the diet contains either choline or methionine in amts. approaching what is considered to be the requirement.

Conversion of 15th carbon of palmitic acid to CO_2 by the intact rat.

WEINMAN, E. O., LOSSOW, W. J., CHAIKOFF, I. L., AND DAUBEN, W. B. *Proc. Soc. Exptl. Biol. Med., 87,* 414-17 (1954).

The amts. of $C^{14}O_2$ expired and the specific activity-time relationships of the expired CO_2 after the injection of tripalmitin-15-C^{14} correspond closely to the results reported previously with tripalmitin-1-C^{14}, tripalmitin-6-C^{14}, and tripalmitin-11-C^{14}. Our present findings thus support our previous postulate that the fasted intact rat, in contrast to certain isolated tissue prepns., converts all C atoms of palmitic acid to CO_2 at practically identical rates. Possible explanations which may account for the differences observed between intact animals and isolated liver prepns. are examd.

Isomers of chlorogenic acid.

DICKINSON, D., AND GAWLER, J. H. *Chemistry & Industry,* 1583 (1954).

During the chromatographic examn. of exts. of the Victoria plum all 3 of the chlorogenic acid isomerides were located, and a further substance A giving similar reactions but having a higher R_f value was also found. Using 9-butanol-H_2O-acetic acid (63:27:10) as a solvent and effecting the sepn. on filter paper, the R_f values found were as follows: chlorogenic acid 0.71, isochlorogenic acid 0.85, neochlorogenic acid 0.62, substance A 0.91. The u.v. and color reactions, including the nitrite reaction, were similar for all 4 compds.

Synthesis of β-linked glucosaccharides by extracts of Chaetomium globosum.

BUSTON, H. W., AND JABBAR, A. *Biochim. et Biophys. Acta, 15,* 543-8 (1954).

Cell-free exts. of mycelium *C. globosum*, grown under specified conditions, were shown to cause dissimilation of cellobiose into glucose and a trisaccharide, which by chem. and phys. tests was identified as cellotriose. In the presence of notatin (glucose oxidase) the synthesis proceeded further and certain simple oligosaccharides were produced. No evidence was obtained to indicate the formation of trisaccharides with linkages other than β-1:4-.

Rapid estimation of free and total cholesterol.

ZAK, B., DICKENMAN, R. C., WHITE, E. C., BURNETT, H., AND CHERNEY, P. J. *Am. J. Clin. Pathol., 24,* 1307-15 (1954).

A simple, rapid and accurate procedure for the detn. of free and total cholesterol is presented that utilizes the comparatively new endpoint device of Zlatkis, Zak and Boyle.

BOTANY

Chlorophyll reaction. Oxidation and isomerization reactions of the chlorophylls in killed leaves.

STRAIN, H. H. *J. Agr. Food Chem., 2,* 1222-5 (1954).

From examn. of the oxidation and isomerization reactions of the chlorophylls in killed leaves it is concluded that reversible isomerization of chlorophylls involves a modification of the phorbin nucleus and not a *cis-trans* isomerization of unsatd. phytyl group. The absence of chlorophyll alteration products in living plants subjected to intense light, darkness, and various oxidation and reduction conditions is taken to support the view that chlorophylls do not undergo extensive chem. change during photosynthesis.

Isolation of lignin from finely divided wood with neutral solvents.

BJORKMAN, A. *Nature, 174,* 1057-8 (1954).

Lignin can be extd. from spruce by first grinding the wood sawdust in a vibrational ball mill in place of the more drastic chem. conditions formerly necessary.

A new amino-acid in the peel of apple fruits.

HULME, A. C. *Nature, 174,* 1055-6 (1954).

An amino-acid believed to be a methyl-hydroxyl-proline has been isolated in the form of fine silky needles from the peel tissue of apples.

MICROBIOLOGY

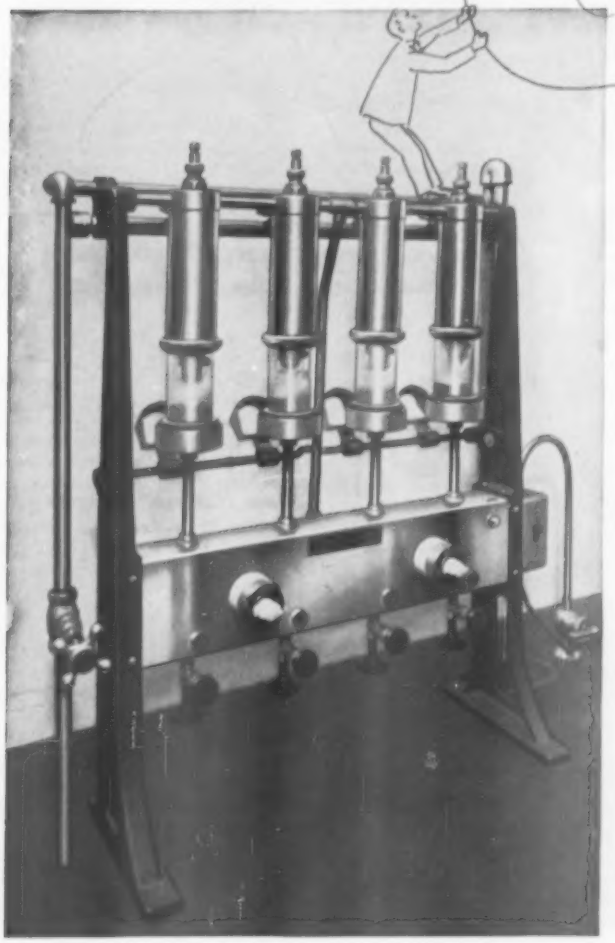
Coliform densities in pasteurized dairy products.

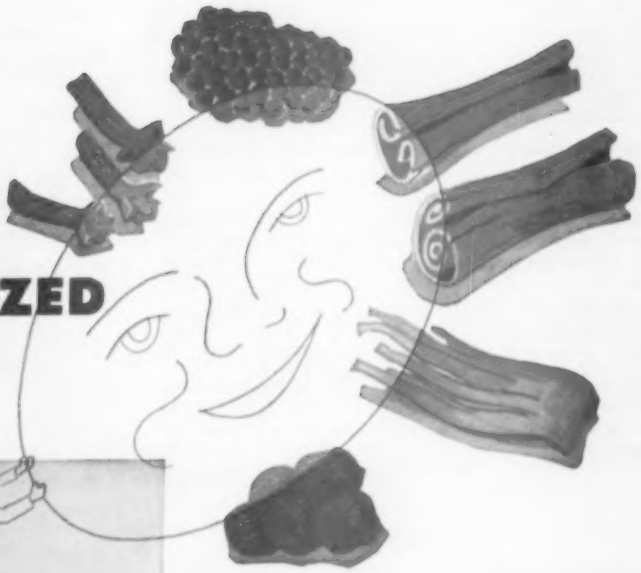
ARCHAMBAULT, J. *J. Milk and Food Technol., 17,* 342-6 (1954).

The tube method appears to be the method of choice for examg. pasteurized samples, the coliform content of which usually should be very low. It offers much less risk of missing gross recontamination, or of yielding grossly discordant results in the hands of different workers and with various pasteurized products, including chocolate milk and cream. If the plating

(Continued on page 20)

PEPPEROYAL AND SOLUBLIZED SEASONINGS





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SELECTED ABSTRACTS

(Continued from page 18)

method be used, two or more portions of different vols. should preferably be plated, including sufficiently small vols. to reduce the risk of failing to detect typical colonies on overcrowded plates.

Potential infectious hazards of laboratory technics. I. Lyophilization.

REITMAN, M., MOSS, M. L., HARSTAD, J. B., ALG, R. L., AND GROSS, N. H. *J. Bacteriol., 68,* 541-4 (1954).

The lyophilizer becomes heavily contaminated during the process of lyophilization. The operator's hands become contaminated with the organism being lyophilized during removal of the ampules. A simple cotton filter is described which prevents contamination of the vacuum gauge and pump.

Separation of proteolytic enzymes of Cloetridium histolyticum.

DE BELLIS, R., MANDL, I., MACLENNAN, J. D., AND HOWES, E. L. *Nature, 174,* 1191-2 (1954).

Complete sepn. of the proteolytic enzymes found in culture filtrates of *C. histolyticum* has been achieved by fractional pptn. with satd. ammonium sulfate solns. neutralized with NH_4OH to a pH of 7.5.

Factors influencing the growth of Shigella dysenteriae 1 in a synthetic medium.

JOHNSON, R. B. *J. Bacteriol., 68,* 604-9 (1954).

A strain of *S. dysenteriae* 1 could be grown in a mineral salts medium contg. glucose as the sole org. compd. if an optimal concn. of the chelation agent ethylenediamine tetraacetic acid or nicotinamide was added. Gaseous O_2 strongly inhibited growth under these conditions, an optimal growth response occurring in an atm. of N contg. 10% CO_2.

NUTRITION

Some experimental observations on the diet and oral hygiene in relation to dental caries.

NEVIN, R. B. Privately printed, 15p. *Biol. Abstr., 29,* No. 1205 (1955).

The effects of cookie/saliva mixt. on the rate of diffusion of lactic acid from between closely spaced glass rods support the conclusion that changes in the phys. properties of food may have a greater effect on caries incidence than variations in sugar content.

Feed digestibility. Chemical method for measuring relative digestibility of animal protein feedstuffs.

GEHRT, A. J., CALDWELL, M. J., AND ELMSLIE, W. P. *J. Agr. Food Chem., 3,* 159-62 (1955).

A simple enzymatic method is useful in detg. the relative digestibility of meat and fish by-products used as feedstuffs.

Disappearance of the growth response of chicks to dietary antibiotics in an "old" environment.

WAIBEL, P. E., ABBOTT, O. J., BAUMANN, C. A., AND BIRD, H. R. *Poultry Sci., 33,* 1141-6 (1954).

The addn. of aureomycin or penicillin to nutritionally adequate diets consistently increased the growth of chicks for the first 21 mos., thereafter, these same antibiotics no longer increased growth rate. The lack of response was attributed to a change in microbial population brought about by a change in cleaning practices and/or the possibility that harmful bacteria had been eliminated through the long-continued use of antibiotics.

Effects of dietary arsanilic acid on chicks.

ABBOTT, O. J., BIRD, H. R., AND CRAVENS, W. W. *Poultry Sci., 33,* 1245-53 (1954).

In a series of chick expts. conducted with practical rations in one particular environment and extending over a period of about one year, growth responses to arsanilic acid and penicillin, which avd. 21 and 19%, resp., diminished and disappeared concurrently. Arsanilic acid at the high level of 500 mg./kg. of diet did not suppress growth or produce any evidence of toxicity.

PHARMACOLOGY AND TOXICOLOGY

Repeated intravenous infusions of oxypolygelatin (OPG) solution in irradiated rabbits.

DETRICK, L. E., DEBLEY, V., AND HALEY, T. J. *J. Am. Pharm. Assoc., Sci. Ed., 43,* 449-52 (1954).

Seven-hundred r. whole irradiation increased the mortality rate of rabbits given 11 consecutive daily intravenous infusions of a modified oxypolygelatin soln. Irradiated but noninfused control animals all survived the 30-day expt. Early deaths in the irradiated infused animals, 25% within 1.5-5.0 hrs. after injections were started, were attributed to cardiac failure. Later deaths, 62% occurring 1-11 days after x-irradiation, were accompanied by hypervolemia, edema, hemorrhage, infection, and pathological changes in the liver, lung and kidney.

The presence of aspirin in human plasma after oral administration.

MANDEL, H. G., CAMBOSOS, N. M., AND SMITH, P. K. *J. Pharm. Exptl. Therap., 112,* 495-500 (1954).

1-C^{14} Aspirin and C^{14}-carboxyl-labeled aspirin were prepd. Aspirin was found to be present in the plasma of humans for approx. 2 hrs. after administration, at levels less than 2 mg. %. It was calcd. that at least a major portion of the salicylate found in the plasma during the first 2 hrs. after drug administration had been formed by the hydrolysis of aspirin after absorption.

Effect of threonine on fat deposition in the livers of mature rats.

HARPER, A. E., BENTON, D. A., WINJE, M. E., MONSON, W. J., AND ELVEHJEM, C. A. *J. Biol. Chem., 209,* 165-70 (1954).

It is suggested that fat deposition in the livers of mature rats, like that in the livers of young rats, fed low protein diets is affected by the balance of amino acids in the diet.

Influence of phytol in the liverfat metabolism.

BERNHARD, K., AND WAGNER, H. *Helv. Chim. Acta, 37,* 2356-60 (1954).

Phytol caused a marked increase in the oxidation of acetate and a reduced synthesis of fatty acids. A "fasting effect" was excluded by estns. of glycogen in the livers, the control of food-consumption and body wt. Tocopherol given in the place of phytol did not show the same effect. Evidently there is no splitting of the C-bound side chain.

The safety and fate of potassium sodium copper chlorophyllin and other copper compounds.

HARRISSON, J. W. E., LEVIN, S. E., AND TRABIN, B. *J. Am. Pharm. Assoc., Sci. Ed., 43,* 722-37 (1954).

The inclusion of up to 3% of potassium sodium copper chlorophyllin in the diet of albino rats over their life span resulted in no indication of toxicity, in that: the growth rate, survival, blood and urine factors, and ability to conceive, were normal. There was no gross or microscopic pathology attributable to the "chlorophyllin." There was no evidence of metal toxicity, and the livers, kidneys, and spleens, did not store increased amts. of Cu, compared with that stored by similar tissues of animals receiving equiv. quantities of $CuSO_4$ or Cu gluconate. Photosensitization did not occur, nor was it possible to incite sensitization by intraperitoneal or local application of the "chlorophyllin."

Plastic packaging materials.

LEHMAN, A. J. *Assoc. Food & Drug Officials U. S., 18,* 129-34 (1954).

A comprehensive review listing known pharmacological data.

PHYSIOLOGY AND MEDICINE

Factors associated with the movement of calcium from the food to the bones of chicks.

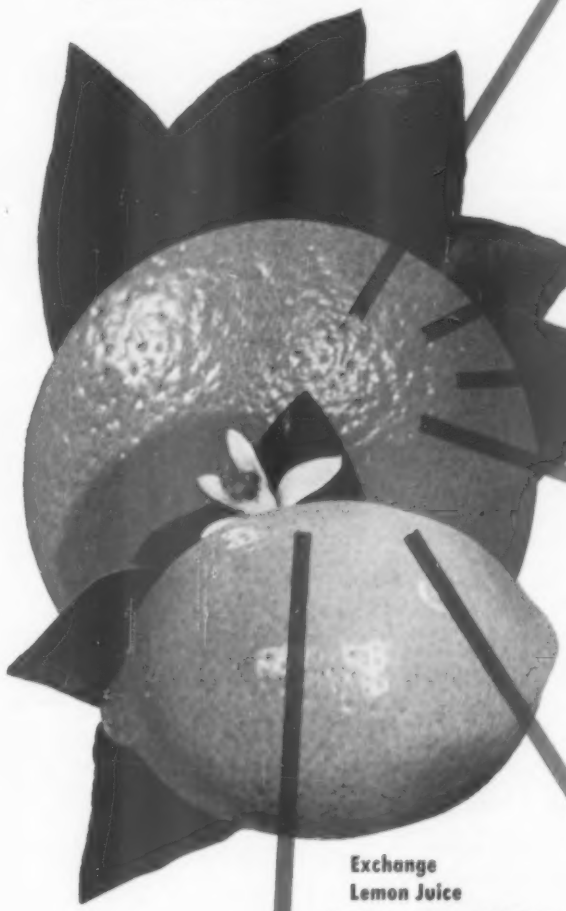
PATRICK, H., AND SCHWEITZER, G. K. *Poultry Sci., 33,* 1199-1201 (1954).

Chicks fed a basal diet plus certain supplements were given 20 mc. of Ca^{45} orally or by intramuscular injection. The activity of the Ca^{45} was dctd. as percentage of dosage given which was

(Continued on page 22)

Look to Sunkist
for progressive research in food processing

Yes, in every field of food processing, the Sunkist Growers laboratories are making ever-widening contributions to the increased quality of food products. Here are some typical Exchange Brand product developments.



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Exchange Oil of Lemon

The 4-to-1 favorite over all other lemon oils combined! The reason is the superior flavor that comes only from California-grown lemons processed by exacting Sunkist standards.

Exchange Preserver's Pectin

Here is *even* jell strength that gives you consistent, complete reliability in setting control.

Exchange Low Methoxyl Pectin

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SELECTED ABSTRACTS

(Continued from page 20)

deposited in the combined left and right tibiae. Supplementation with milk albumen and casein increased the amt. of Ca deposited. An organic factor besides vitamin D was thought to be assocd. with bone mineralization.

The analysis of blood iron.

DICKENMAN, R. C., CRAFTS, B., AND ZAK, B. *Arch. Biochem. Biophys., 53,* 381-6 (1954).

A procedure is presented which makes possible the analysis of blood Fe by 3 short and simple steps.

Diet in cirrhosis of the liver.

ABBOTT, F. E. *J. Can. Dietet. Assoc., 15,* 10-14 (1953); *Biol. Abstr., 29,* No. 623 (1955).

Food is most effective against hepatic cirrhosis. The incidence and severity of hepatic necrosis increased as the protein S in the diet diminished, in animals. Deficiency of S-contg. amino acids and of tocopherol is the leading dietary condition in the development of massive hepatic necrosis in rats. The variance of the carbohydrate content has little, if any, effect on the incidence of hepatic injury. Increasing the fat content increased liver necrosis.

Absence of color vision in cat.

MEYER, D. R., MILES, R. C., AND RATOOSH, P. *J. Neurophysiol., 17,* 289-94 (1954); *Biol. Abstr., 29,* No. 885 (1955).

It is concluded that cats are completely color-blind. This finding is consistent with the dominator-modulator theory, but not with laminar theory in its present form. It does not support the inference that potentiation of electrocortical responses to geniculate stimulation indicates the presence of a trichromatic mechanism in this species.

FOOD AND FOOD TECHNOLOGY

FATS AND OILS

A new concept on the mechanism of autoxidation of methyl oleate, linoleate, and linolenate.

KHAN, N. A. *Can. J. Chem., 32,* 1149-54 (1954).

Objective is to study the mechanism of initial reaction that leads to the quant. formation of hydroperoxides.

The use of thiobarbituric acid as a measure of fat oxidation.

SIDWELL, C. G., SALWIN, H., BENCA, M., AND MITCHELL, J. H. *J. Am. Oil Chemist's Soc., 31,* 603-6 (1954).

An evaluation of thiobarbituric acid (TBA) as an agent for the measurement of fat oxidation was made by the application of several empirical procedures to animal and vegetable fats. An extn. procedure was used for removing the products of oxidation. The reaction with TBA was conducted in a boiling H_2O bath to produce a red color, which was then estd. spectrophotometrically.

A method of calculating fatty acid composition from ester fractionation analysis.

JONES, E. W., AND MCLEAN, M. A. *J. Am. Oil Chemists' Soc., 31,* 473-5 (1954).

The calcns. involved in ester fractionation analysis require the soln. of sets of 3 simultaneous equations. Repeated soln. of these equations is avoided by obtaining expressions for the proportions of the components. Frequent analysis of similar fractions is further simplified by the prepn. of tables, slide rules, or nomograms.

FLAVORS

Superior powdered flavors.

BRODERICK, J. J. *Food Eng., 26,* 83, November, 1954.

Mainly a discussion of coatings used to seal in flavors and various processing methods.

FRUITS AND VEGETABLES

Fruit color destruction. Decolorization of anthocyanins by fungal enzymes.

HUANG, H. T. *J. Agr. Food Chem., 3,* 141-6 (1955).

Several crude fungal enzyme prepns. exert a significant decolorizing effect on exts. of pigments derived from berry fruits. The over-all decolorization process involves an enzymatic hydrolysis of the anthocyanin to anthocyanidin and sugar, and a spontaneous transformation of the aglucone into colorless derivs.

Preserving potatoes.

Science News Letter, 66, 373 (1954).

Research at the Univ. of Michigan has shown that spuds irradiated in their lab. could be preserved for a year at 48° F.

STARCHES

The effect of citric acid on selected edible starches and flours.

HANSULD, M. K., AND BRIANT, A. M. *Food Research, 19,* 581-9 (1954).

Effects of increasing amts. of citric aicd on the thickening and gelling properties of corn starch, two wheat starches, and two wheat flours were studied. Increasing concns. of citric acid lowered the gelatinization temp. of the starches, increased the fragmentation of the granules, reduced the max. viscosity, and increased the amt. of subsequent thinning of the pastes. Starch gels become softer with increasing quantities of citric acid. Flour gels stiffened with small amts. of the acid and softened with larger amts.

TASTE TESTING

Modern taste testing from the viewpoint of the master brewer.

GRAY, P. P. *Wallerstein Laboratories Communications, 17,* 241-58 (1954).

Discusses general and specific aspects of taste testing. Defines objective, describes modern methods of minimizing bias, discusses statistical applications. Example of various methods of sample evaluation are given (triangular test, ranking tests, consistency test, etc.). While offering nothing new, it is a fair general, non-tech. discussion from this specific point of view.

ORGANIC CHEMISTRY

The preparation and structure of a synthetic polyglucose.

RICKETTS, C. R. *J. Chem. Soc.,* 4031-2 (1954).

Anhyd. glucose exposed to vapors of concd. HCl gave in 4 days at room temp. a 17% yield of polymeric non-dialyzable material which gave evidence of being a polymer of from 10-20 glucose units mostly connected by 1:6- linkages, and hydrolyzable with acid to isomaltose and glucose.

Polygalacturonic acid amides.

SOLMS, J., DENZLER, A., AND DEUEL, H. *Helv. Chim. Acta, 37,* 2153-60 (1954).

Liquid NH_3 will quantitatively convert polygalacturonic acid methyl esters into amides without causing depolymerization. The polymeric amides are less subject to acid hydrolysis than monomeric amides. With increasing amidization H_2O soly. decreases and the ability to gel increases: such high-mol. amides are easily coagulable by electrolytes due to intramol. and intermol. H bonding.

Structure of cotton alpha-cellulose.

DAS, D. B., MITRA, M. K., AND WAREHAM, J. F. *Nature, 174,* 1058-9 (1954).

The authors explore the possibility that cotton α-cellulose has a structure based upon both pentoses and glucose and not merely glucose.

PACKAGING

Fuse-welding gun for polythene.

Packaging (Brit.), 59, December, 1954.

A transformer-operated solder gun is claimed to be well suited to either straight-line or fancy shaped sealing of polythene film.

Needle penetration of petroleum waxes.

TAPPI, 37, 134A-9A, November, 1954.

Three new TAPPI Suggested Methods for the analysis of paper converting materials: needle penetration of petroleum waxes, particle-size distribution of coating clay, viscosity of starch and starch products.

(Continued on page 26)

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3 **To Meet the Taste Preference of Those Who Like Things "Less Sweet Than Usual"**

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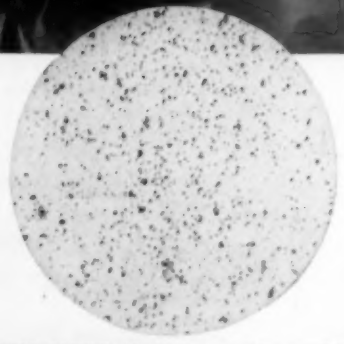
In the laboratory of Wm. J. Stange Co., a food technologist compares 50-A micro-ground Spice with ordinary ground spice under a microscope.

NEW MICRO-GROUND SPICES

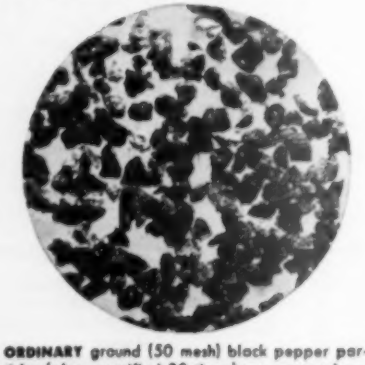
Although spices themselves haven't changed in a thousand years, unsuspected qualities have been discovered in them by a recently developed process called micro-grinding. Patented by Wm. J. Stange Co., this process consists of feeding whole natural spices into specially designed water-cooled roller mills which pulverize the spice into particles so minute, that only thru a microscope can you appreciate their size. Compared to ordinary grinding methods, the new process produces 50 to 100 times more particles of spice . . . millions more per pound.

The minute size and vast number of spice particles permit uniform and thorough distribution throughout each batch of food product, eliminating specking or the formation of hot spots.

Most important, however, is the standardization of flavor made possible by this unique process. This, in addition to the total utilization of flavor from the spices themselves makes this new spice one of the really important developments in the food processing industry.



MICRO-GROUND Black Pepper spice particles (here magnified 30 times) are practically invisible to the naked eye.



ORDINARY ground (50 mesh) black pepper particles (also magnified 30 times) appears as huge boulders by comparison with micro-ground spice.

STANGE Announces New 50-A® spices

Natural Whole Spice Ground to Microscopic Fineness!

Only 50-A micro-ground spices . . . originated by Stange . . . give you the true flavor of ground spices PLUS controlled uniformity, together with the following completely new characteristics—

- All the flavor and color of natural spice without the specks
- More uniform distribution
- Maximum availability of flavor
- Constant control of flavor intensity
- Maximum retention of flavor
- Constant spice levels during shelf life
- Easy to use, powder form. Available in 50 to 250 pound bulk containers, or in exact-weight, batch size packages.
- Available in individual spices or complete seasoning blends

For complete details on applying new Micro-Ground 50-A Spices to your fine foods, write, wire or phone—

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View of battery of special roller mill equipment processing natural spice into 50-A Micro-ground Spice. The large steel rollers, between which the spice is ground, are perfectly smooth and turn at differential speeds to cause a shearing action between the smooth surfaces. Rollers are water-cooled internally to maintain the spice at a low temperature and to prevent loss of volatile flavors.

MICRO-GROUND SPICE..... .....ORIGINATED BY STANGE

Wm. J. Stange Co. who last year celebrated its 50th anniversary, spent more than two years perfecting the micro-grinding process. Sold under the copyrighted name of 50-A Spice, these new seasonings are fully protected by patents and supplied to the food industry by Stange exclusively.

Not only are individual spices: pepper, nutmeg, cinnamon, etc. available in micro-ground form but in combination with soluble C.O.S. (Cream of Spice) Seasonings. These special blends are called Micro-Cream. By combining the two types of spices, 50-A and C.O.S., Stange can now produce seasoning blends utilizing the special advantages of each to achieve the most satisfactory flavor, color and solubility in the finished product. Micro-Cream spice blends, too, are flavor controlled to insure uniformity.

STANGE'S EXPERIMENTAL KITCHENS, laboratories and technical staff are available to develop special seasoning blends, or assist you in creation of new products.

SELECTED ABSTRACTS

(Continued from page 22)

Controlling bloom in candies.

HEATON, E. K., COWAN, B. G., AND WOODROOF, J. G. *Modern Packaging, 28,* 139-44+, December, 1954.

The type of packaging is a detg. factor in protecting refrigerated chocolate covered candies from moisture damage. Discussion and results of tests covering sugar bloom and fat bloom occurrence in various types of packages and storage conditions are included in graph form.

RADIOCHEMICAL TECHNOLOGY

Costs presented on ionizing radiation processing.

Atomic Energy Newsletter, 12 (10) 4 (1954).

A cost analysis by Applied Radiation Corp. using a linear accelerator shows that pre-cut meats in packages 0.7 in. thick can be pasteurized for $1.06/ton, increasing shelf life 5-fold (normal refrigeration).

STATISTICS

Some observation on sensitivity and repeatability of triad taste difference tests.

HOPKINS, J. W. *Biometrics, 10,* 521-30 (1954).

In a series of some two thousand triangular taste tests definite "training" of the panel was indicated, as also the persistence of individual differences in sensitivity during "training."

The determination of single-sample schemes for percentage defectives.

HORSNELL, G. *Appl. Statistics, 3,* 150-8 (1954).

A table is provided for rapidly determining the single-sample rule for a wide variety of prescribed risks of making wrong decisions. The author describes an easy method of drawing the OC curve. From it one can estimate the percentage of times that a product of any percentage defective will be accepted by the rule. The bounds on the percentage defective in the whole product can be established once a sample has been taken.

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(Continued on page 32 following technical papers)

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Scientific and Technical Progress in Yeast and Bread Production[a]

CHARLES N. FREY
Appert Medalist, 1954

The Institute of Food Technologists fulfills a unique function in bringing together scientific men representing different categories of science and technology, thus providing an intermingling of men and ideas which has proved fruitful over the years. Our annual meetings have added greatly to the pleasures of life by enabling us to meet the brilliant women and men who attend and make up our membership. We are thus greatly indebted to Dr. Samuel Prescott of the Massachusetts Institute of Technology for his efforts in bringing into being our dynamic and rapidly growing organization.

Science has made a terrific impact on every nation, and this is especially true in America. When I was a student nearly half a century ago, the prominent men in science were working in European laboratories, and many American scientists completed their education by several years' study in Europe before entering on their duties in American universities or in Government positions. The men such as Pasteur, Lavoisier, Liebig, Emil Fischer, Carl Voit, Lawes and Gilbert, Darwin, G. Mendel, Boussingault and C. Bernard, who had a great influence on American science, especially the fundamental sciences underlying food technology, nutrition, and agriculture, were European.

It took years to translate some of their fundamental discoveries into practice. Scientific laboratories were not a part of the industrial organizations, and there was no well organized effort to adapt the discoveries of science to food products or to the production of food. The nineteenth century was vigorous and exploding with ideas, but it had not fully developed sound methods for the application of science to industry. In 1846, W. B. Rogers proposed the organization of an institution, the Massachusetts Institute of Technology, to teach science, mechanic arts, agriculture, fine arts, and education. In 1856, the Michigan Agricultural College was established. At Troy, New York, in 1824, Rensselaer was founded. In 1862, President Lincoln signed the Morrill Act which established the land grant colleges. These efforts to apply science to the affairs of men of all classes were significant expressions of the impact of science on the minds of those responsible for the social and economic progress of that age.

It took decades to perfect the uses of electricity and to mass produce automobiles economically, but today the great discoveries of the laboratory are scarcely completed before they are taken to the production department, and immediately thereafter, the sales department begins planning its campaign of education. We have come to accept this procedure as normal. We are no longer astonished by rapid and colossal developments and great achievements. Our business management has found a way to translate science into practice and make it financially profitable to worker, consumer, and enterpriser.

Science and art have existed for many centuries, but it has been difficult, and at times impossible, to develop applications of science and mathematics in a regimented society. Our present situation in a free society may not continue in the distant future unless a broader grasp of the responsibilities each citizen must assume becomes an ingrained characteristic of our people.

THE SCIENTIFIC SPIRIT IN HISTORICAL PERSPECTIVE

Let us look back for a moment to the accomplishments of Greek science — 600 to 400 B.C. Theoretical and practical science flourished, especially in Asia Minor, and a number of very interesting applications were made. Unfortunately, Socrates did nothing to encourage the practical applications of science. Socrates stated that the proper study of mankind is man, and he diverted the course of philosophy from science to metaphysics.

The historian, Xenophon,[b] stated that science is not accepted as a field by the nobility and the educated. "What are called the mechanical arts," he wrote, "carry a social stigma and are rightly dishonored in our cities. For these arts damage the bodies of those who work at them or supervise them, by compelling the workers to a sedentary life and to an indoor life, by compelling them, indeed, in some cases to spend the whole day by the fire. This physical deterioration results also in the deterioration of the soul. These citizens do not have time to perform the offices of friendship or citizenship and consequently are considered bad friends."

Ancient civilization continued to be based on slavery as a source of power rather than on the application of science. This philosophy and the slave economy prevailed in spite of the fact that one of the great Greek scientists, Strato, who lived about 260 B.C. stated in reference to scientists, "They can provide us with the fundamental requisites of a civilized existence."

During the first centuries of the Christian era, the theoretical and the applied sciences languished, and during the dark ages, practically disappeared. The light of Greek science, submerged by the storms and tides of twelve centuries of barbarism and superstition, glowed with undiminished brilliancy as the curtains of ignorance were lifted by the inquiring spirit of the men of the Renaissance. It was western Europe that gave us the rebirth of science, and during the last three centuries fundamental and applied knowledge developed at an accelerated rate, and gave us the transformed world we have today.

In America the fundamental sciences underlying food and nutrition made rapid progress during the first part of the present century. While the European scientists developed some of the principal fundamental work, the greater part of the scientific developments and their application were carried out in America. Such names as S. M. Babcock, S. C. Prescott, H. Russell, Theobald Smith, L. R. Jones, H. W. Wiley, R. Gortner, J. Goldberg, S. Johnson, R. Chittenden, E. B. Hart, E. V. McCollum, J. B. Osborne, L. Mendel, H. Sherman, C. Swanson, C. Bailey, C. Elvehjem, H. Steenback, and H. Evans became associated with food technology and nutrition because these men made fundamental as well as technological contributions in these fields.

It is well that we cherish and promote the great traditions of science, and that we continue to maintain the freedom of action which has been our privilege in the past. "Every human right

[a] The Appert Award Address, presented at the Fourteenth Annual Meeting of the Institute of Food Technologists, the Biltmore Hotel, Los Angeles, California, June 30, 1954.

[b] B. Farrington, *Greek Science*. I, p. 24.

worth having," Lewis B. Hammett said in a recent address given at the meeting of the American Chemical Society in Kansas City, "has to be won by human struggle against the forces of nature or against the forces of evil within man. No human right won has ever continued to exist for long without an unceasing effort to maintain and defend it. The human right is a privilege which man retains only if he accepts the responsibility of protecting it. Man's right to the search for knowledge is no exception. It is a right which can easily disappear all over the world if it is not defended."

When the control over man and science becomes the preoccupation of the ruling classes, the task of mastering nature may become the forced labor of another class. Thus science takes on a new and dangerous aspect in certain nations. How can we continue to maintain freedom and incentive for research in our democracy when such large sums are required to maintain laboratories? If government aid becomes necessary, it should provide support, but government should not seek control.

THE SCIENTIST'S ENVIRONMENT TODAY

Today we are confronted with perhaps the greatest dilemma that scientists have ever faced. Since the atomic age began, the government finds it necessary, and there appears to be no alternative at present, to lock up some of the fundamental secrets of science. Only a few are permitted to have all knowledge and to view some of the new horizons of science. The rest of mankind is relegated to an inferior position and deprived of the new facts whereby further knowledge is gained. In essence we have established a caste system into whose hands the most significant knowledge of mankind has been entrusted. Those who have this heavy responsibility have assumed it as a duty to the nation. They have not seized their power. It is encouraging to read that the President of the United States is endeavoring to extend the participation of industry and universities in developing some of this restricted knowledge.

Although Galileo was forbidden to teach his scientific theories, his work survived, and while we recognize that our national existence is at stake, and that in these critical times certain protective measures are necessary, let us hope that in the not distant future the world situation may improve and the doors of the temples of science may be thrown open again for all men to enter.

It is especially important that the young men who are seeking and will be seeking their advanced degrees in universities be given opportunities to carry on research wherever the mind desires to explore the infinite prospects of the universe. Should generations of young men be restricted in their desires to do fundamental research in certain fields to which their interest and intellect direct them, and be denied access to important areas of scientific knowledge, the cost to our society may well be beyond comprehension. In the end it might destroy us.

It is the duty of every scientist to see that fundamental science is well supported and that students are encouraged to study science. We should urge that students be properly classified from the standpoint of military service, and that restricted knowledge be made available to us as soon as the national interest, which we believe is in the hands of wise and experienced men, makes this possible.

We are told that Russia is training, and training well, more scientific men per 100,000,000 population than we are. Between 1952 and 1953 in the United States there was a drop of 11% in number of men receiving bachelor of science degrees in engineering, and the projection for 1954 is that we shall have another drop of 11%. It is estimated that 150,000 men with some scientific training are made available by graduation each year in the United States, but this number may be less than our present needs. We cannot permit ourselves to be relegated to an inferior position in science.

In these brief discursive remarks I have tried to point out some of the environmental factors that have influenced the character and growth of our industrial development. In order to promote industrial research and to make it truly effective as an expression of our civilization and of our fundamental science, our social and economic philosophy must be fully coordinated with our industrial life. We can accelerate our scientific progress by the harmonious cooperation of all the other components of society.

THE FEDERATION OF SCIENCE AND INDUSTRY

I shall endeavor now to point out some significant developments in the food industry which occurred during the last forty years and which involved the cooperation of fundamental scientists, industrial scientists, government, industry, and the free use of knowledge obtained from many lands. It is necessary in order to maintain scientific progress at an accelerated rate that the free exchange of knowledge among nations be encouraged.

At the beginning of the century it began to be recognized that in America the baking, milling, and yeast industries are mutually interdependent, but this close relationship, while recognized commercially in America after the Centennial of 1876,* was not too well integrated from the standpoint of scientific research. Far more progress could have been made if the research work which each industry developed had been more comprehensive, and if more information in respect to the individual developments of each industry had been made widely available. The fine spirit of cooperation exhibited by the United States Government laboratories, the Food and Drug Administration, the Department of Agriculture, the universities, and some of the experiment stations in promoting our industrial development should be commended.

In the latter part of the nineteenth century several laboratories were established in Europe which coordinated the research from various fields and which were often located, as in Berlin, in the same institution. The Gärungs Institute and the Bäckeri Institute with the milling department were closely associated, and gave advancement, coordination, and direction to the fermentation, baking, and milling industries. The laboratories at Weihanstephan and at Munich should also be included. The Lintner method was developed at Weihanstephan. The fundamental and significant work of Neuberg, Hill, Wieland, Warburg, Sorensen, Fischer, and Meyerhoff followed the important work initiated by such outstanding investigators as Pasteur, Büchner, Hansen, Beyerinck, and Liebig in Europe, and by Harden and Young in England.

In England the work of Jago and the classical researches of H. Brown, O'Sullivan, Adrian Brown, and Armstrong stimulated research and promoted industrial progress in many areas. In Denmark the Carlsberg Laboratory, and in Holland Beyerinck and Kluyver were outstanding in their contributions to fermentation and to the study of microbiology. Euler made important contributions from Stockholm. The Pasteur Institute, through the leadership of Pasteur, his associates, and successors, and the contributions of Liebig and his school, set the stage for the great advancements and progress in the biochemical and bacteriological fields which we see about us today. The work of Lawes and Gilbert in England and that of the Bureau of Plant Industry, the Bureau of Soils, and several universities and experiment stations in the United States contributed greatly to the advancement of our knowledge of fertilization of soils, the selection and breeding of new varieties of cereals, and the physiology and biochemistry of living processes.

You will recall that Pasteur pointed out that yeast could be grown on ammonium tartrate or inorganic nitrogen. He also noted that yeast, probably brewers' yeast, could be grown in a medium of inorganic salts, sugar, and ammonium tartrate, but its growth was greatly accelerated if organic material was present or if large seedings were used. He distinguished between aerobic and anaerobic fermentation, and this discovery may be regarded as one of his great achievements. Pasteur showed by microscopic and chemical means that some of the so-called "diseases of beer" were due to foreign organisms which reduced alcohol production or converted the alcohol to acetic acid and other compounds. As a result, the beer had a very undesirable flavor.

* A model Vienna bakery was established at the Centennial. Compressed yeast was used in preparing bread and rolls.

Hansen in Copenhagen developed an ingenious method, using capillary tubes, into which he drew a dilute suspension of yeast cells, to isolate single cells. Thus he established the pure culture method for propagating yeast. This procedure was advanced still further by Koch's gelatin plate method. In more recent times the Fitz and Chambers micromanipulators, the excellent microscopes now manufactured with all their attachments, and the electron microscope enable the microbiologist to make rapid progress in isolating cells and spores of yeast, and in learning more about the structure and cytology of the cell.

When World War I began, the yeast industry was still in a very primitive state. The practice of aerating yeast was followed, but aeration was not sufficient to produce high yields. Yeast was generally grown on extracts prepared from malt, corn, and malt sprouts, but this medium is not appropriate for high yields. Pure strains were difficult to maintain. The yields of yeast based on the grain used were low, 15 to 25%. The yeast, when fresh, was of fair baking quality but lacked uniformity and stability, its fermentation rate was often erratic in hot weather and it contained many foreign organisms.

The baking industry was operating with inadequate ovens and generally with slow speed mixers. Temperature and humidity controls for fermentation and proofing of doughs and for baking ovens were being considered by some of the leading bakers. Many of the operations were still carried on by hand. Enzyme control was inadequate and not well understood.

Flours were not uniform, and they were often over or under diastated. Farmers raised many types of wheat. Although a limited number of studies on the influence of variety, protein quality, effect of climate and soil had been undertaken, the miller usually purchased the wheat available in his area and milled it. Millers and bakers, however, began to consider their problems in the light of the newer scientific knowledge. Dumas in 1843 had advocated baking tests conducted under controlled conditions in the laboratory. In America, about 1915, a number of important developments to control the purchase of materials and to control production were initiated, such as analyses of protein, water, and ash of flour; gas tests, baking tests, and wet and dry gluten tests.

Shortly after World War I began, the entire economy of Europe and of the United States was altered. Food supplies were sought by all the belligerents. Shipping was curtailed by submarines. Corn, malt, and malt sprouts were no longer freely available. The yeast industry and the baking industry faced a serious situation, for flour was in short supply in Europe. America was trying to fill Europe's needs and was substituting corn, oats, and potato flours to replace some of the flour shipped to Europe.

SCIENCE AND INDUSTRY TAKE EPOCHAL STRIDES

The period during and following World War I was the beginning of an epoch which ended in 1945 when the atomic age began. During this period several momentous developments took place which greatly influenced the future of several food industries. In 1914, Haber and Bosch developed the synthesis of ammonia from atmospheric nitrogen by a catalytic process. The process solved one of the great problems facing the human race. No longer was man entirely dependent on the microbes of the soil to supply nitrogen and make it available for plant growth. Shortly after the ammonia process was well developed commercially, the synthesis of urea became a commercial process. Recovery of ammonium sulphate from the destructive distillation of coal was also practiced.

In America Swan and his associates and the Monsanto Chemical Company developed a commercial process for the production of pure ammonium acid phosphate, calcium acid phosphate, and phosphoric acid. At that time the commercial phosphates available for fertilizers contained excessive amounts of lead, arsenic, and fluorine.

The development of centrifugal machines for blowing air and also the use of improved displacement type blowers made it possible to pump air efficiently under low pressure.

Filter presses were chiefly of the plate and frame type. The utilization of the Sweetland and Oliver filter presses in filtering molasses and malt extracts proved to be economic, and a better clarification of the filtrate was obtained than with the older methods. Fortunately, various types of filter cell were available. As some types did not remove the vitamins from molasses, and other types adsorbed vitamins, studies were undertaken to cover this situation. The developments in the field of filter aids were of primary importance in making possible the use of molasses and the filtration of grain extracts in the American, Sweetland and Oliver types of filters.

Centrifuges were used for concentrating yeast. They were small and not too effective mechanically. The orifice was constructed of brass which became corroded by the acids of the yeast and of the wort. Thus the opening enlarged, and the desired concentration of the yeast was not attained. It was necessary to keep a mechanic on hand to check the size of the orifices and to replace those which had been enlarged. At the present time centrifuges with stainless steel parts with a capacity of 5000 gallons an hour permit continuous operation over many months with effective separation.

Figure 1. Centrifuges used in modern yeast production permit continuous operation over many months with effective separation.

Improvement in the quality and handling of stainless steel and the lowered cost of equipment made from stainless steel enabled industry to use acid resistant materials in the construction of fermenters, cookers, pipe lines, and storage tanks. This equipment is easy to clean, is noncorrosive, and possesses fairly good heat transmission. Stainless steel replaced copper and brass which had been standard equipment. The use of inorganic nitrogen and phosphorus compounds in growing yeast produced acid end products which attacked copper and brass equipment to such a degree, in many instances, that the growth of yeast and its quality were greatly impaired.

About 1910-1912 Dr. S. P. L. Sorensen introduced the method of determining hydrogen ion concentration. This proved to be of fundamental importance for the control of various biological processes, such as growing organisms of various kinds, control during fermentations, as in baking and in alcohol production. Biochemical and physical reactions could be more effectively analyzed, and enzyme activity could be measured under more precise conditions. W. M. Clark and S. F. Acree introduced the work into America and set up equipment in their laboratories for work in this field. It was my good fortune to work with Acree in 1916-1917, and thus it was possible to grow yeast and fungi under pH control. He gave assistance and advice in some of the first work on growing fungi and bacteria with pH control.

The control of pH is obviously of fundamental importance in biology and biochemistry, and its value was immediately appreciated. Equipment was not generally available in the supply houses and so it was necessary to build whatever items we used. We prepared distilled water in block tin stills and generated the hydrogen gas we required. We built and assembled units to make pH equipment. The calomel cell and platinum electrodes were made in the laboratory.

Dr. Sörensen developed the method of formol titration for determining the ammonia content of a biological medium. This proved to be one of the basic procedures in growing yeast. It

enabled the operator to follow rapidly the utilization of ammonia during every stage of fermentation. Without this procedure, modern methods of growing yeast could not be operated efficiently.

The use of special types of litmus paper which responded with increasing intensity of color at pH below 6.8 to about 6.0 was also very useful because pH could be determined in a certain range quite accurately. A number of indicator dyes were also widely used. The availability of accurate and sensitive Balling spindles helped materially in regulating the intake of carbohydrates by yeast.

In 1914, the announcement by McCollum, and Osborne and Mendel of the discovery of fat soluble A and water soluble B opened a new era in biochemistry and biology. From the vitamin work a broader understanding of the nutritive requirements of yeast and of yeast growing was obtained. Human and animal nutrition research entered a new epoch which proved to be productive. These researches had wide ramifications which influenced the biological and medical sciences. The food industry, and especially the baking industry, felt the impact of the newer knowledge. Enrichment of bread, corn meal, and rice, and the preservation of vitamins during the processing of cereals, fruits, and vegetables are contributions arising from the developments in nutrition and biochemistry, the importance of which is impossible to evaluate.

Figure 2. Scene in the fermentation room of a modern yeast manufacturing plant.

I have sought to give you a background of the situation as it existed in parts of the food industry about 1920. Science was creating tremendous potentialities. It was imperative to apply the fundamental knowledge rapidly being made available, and to coordinate experimental work which was developing in various scientific areas. The necessity of applying the new techniques of science and the development of team work in the prosecution of projects became apparent to those responsible for the operation of a laboratory. There was never quite enough fundamental biochemical knowledge to answer many of our problems or to meet all our needs. Many individual discoveries which had to be evaluated and correlated with other observations in related fields made the work of application arduous and difficult. Fortunately, some of these isolated discoveries were finally generalized and thus simplified. Progress was thereby accelerated. Equipment manufacturers were making effective efforts in developing better equipment, but each year our demands on them became more difficult to fill. It was also necessary to educate management to assume its responsibilities and to create the facilities to apply science to industry.

A CHALLENGING PROBLEM

During 1917-1919 the shortage of grain compelled the manufacturers of yeast to use molasses to supplement or replace the grains and malt sprouts normally used. Cane molasses and beet molasses were available, but no one knew how to use them. Here was a situation that offered a challenge to anyone trained in biochemical science and in biology and engineering.

Our problem was to grow yeast in molasses, generation after generation, to maintain the yield, quality, stability, color, odor, rate of reproduction, and fermentability equivalent to that of a grain yeast. The baking industry wanted a yeast of good color and odor, good stability, and rapid rate of fermentation. Any change in quality would involve the prestige of the maufacturer, and possibly the loss of his customers.

The Corby Fellowship at the Mellon Institute, headed by F. M. Hildebrandt, was given the assignment by Mr. Corby of the Corby Yeast Company to develop a new type of yeast from molasses, and also to develop an active dry yeast, equivalent in fermenting activity to that of a fresh yeast based on an equivalent dry weight. The yeast should disperse readily, have a good odor, and maintain its stability and rate of fermentation for at least one year in a sealed package.

We began work on various strains of yeasts. Genetics, following the rediscovery of Mendel's law by DeVries, was becoming a well defined science, and offered possibilities as a means of determining the inheritable characteristics and the development or enhancement of desirable characteristics of yeast cells. It was also believed that new strains might be developed by crossing as a result of more intensive investigation of the sexual cycles of yeast. Studies were made of various strains of yeast covering, for example, the nutritive requirements including vitamins and minerals, gassing power, invertase activity, fermentability of maltose, cane sugar, dextrose, levulose, and galactose, salt sensitivity, pH, levels best suited for growth, copper sensitivity, stability, ash content, nitrogen requirements for growth, phosphorus requirements, autolytic activity, aeration requirements, response of yeast when placed in doughs (baking tests), types of sugar most rapidly fermented, nitrogen content of finished yeast, types of nitrogen, and phosphorus compounds best suited for yeast growth and fermentation.

One of the problems which had to be solved was the relation of air flow to the yield of yeast. Unless there are means of measuring air flow and determining the aeration requirements at various levels of nutrition, yields of yeast on raw materials cannot be evaluated. Practically all the applied work on yeast growth reported in the literature before 1930 was valueless because this important item had been neglected.

There was no instrument available which was adapted to measure air flow in small fermenters. With the assistance of the machine shop at the Mellon Institute, Mr. Coleman and Mr. Emson of the staff, eight orifice meters were built which, under uniform air pressure of 20 pounds, gave practically equivalent air flow. Aerators had to be built to give distribution of air. The area of the fermenter in this type of aeration determines the amount of air required in a given fermenter, whether the fermenter is 5 feet high or 10 feet high. The size of the openings of the aerator and the number of holes per square inch had to be adjusted to varying sizes of fermenters in order to realize maximum utilization of air.

Yields of yeast may be decreased 30-40% by insufficient aeration. Schultz, Kirby, and Bühring found that aerating cones to be most effective should have a uniform pore size, the diameter not exceeding the length of the yeast cell. The problem of aeration is an important one. It is not completely understood at the present time, and much more work in this field is desirable. Its importance can be estimated by pointing out that in modern yeast production 15-16 pounds of air are required for growing a pound of fresh bakers' yeast.

UNDERSTANDING AND CONTROLLING YEAST PRODUCTION

As previously stated, work on yeast strains was undertaken. Research in this field was not well advanced in the United States. There were no centers where cultures were maintained

and classified, and data on their characteristics recorded. Consequently, we were compelled to establish and maintain our own collection. The American Type Culture Collection began to function after World War I. Its funds were limited, and consequently, it could not carry out extensive investigations or publish the data which some who contributed cultures could have supplied.

The problem of developing a suitable and easily prepared culture medium was the work of many years. Various types of grain extracts, beet molasses, cane molasses, dextrose, levulose, cane sugar, hydrolyzed proteins, and synthetic solutions containing known mineral requirements, trace elements, and bios factors were tried. Many attempts were made to develop effective media and methods for producing sporulation of various types of yeast. This problem is still with us, and much more fundamental work is desirable in this field. How to maintain cultures is also a matter for further research. This involves the most suitable medium, the temperature of the incubation period, the temperature at which growth should take place, and length of time in storage before transfers are made.

The genetic work of the Carlsberg Laboratory under the direction of Winge and Laustsen, and the contributions of Lindegren, Wickerham and Spiegelman in the United States from 1935 on have been productive. About 1930, Mr. Swift was able to develop the Fitz micromanipulator which enabled us to isolate single cells and to separate the spores in an ascus. We were equipped at the Laboratories to carry out the development of the cells to a stage where the stability of the culture and its characteristics, such as baking properties, could be determined. To facilitate our studies we also prepared moving pictures of budding yeast cells and of sporulating yeast cells.

One of the most serious problems concerned the search for a suitable carbohydrate source for the growth of yeast. Good beet molasses was available in limited amounts, but it was expensive and required clarification. Due to the presence of sulphur dioxide, it was often toxic to yeast. Certain types of beet molasses were also deficient in growth factors. Cane molasses (black strap and refiners') was plentiful and cheap, but it required clarification and supplementation with grain extracts and nitrogenous and phosphatic materials. It, too, was often deficient in growth factors. The yeast produced directly from it by simple dilution was dark, almost pitch black in color. The molasses could not be filtered in a Sweetland or Oliver press or in a plate and frame press; nor was it possible to filter the yeast after growth was complete.

Two methods of clarification were eventually worked out. One consisted of treating the molasses diluted 1 to 4, or 1 to 2½, with water and adding superphosphate and soda ash, or ammonium acid phosphate and soda ash. Sodium bicarbonate or finely precipitated calcium carbonate was also tried. The other method consisted in treating the molasses diluted 1 to 4 with sodium silicate and water, the sodium silicate having a composition of approximately 50% sodium oxide and 50% silicon dioxide. In each method, on heating, a voluminous precipitate was obtained which caused the molasses to filter readily, and by means of filter cell, a brilliant solution was obtained.

The use of ammonium sulphate involved many problems. The commercial product was not pure, and the yeast utilized the ammonia leaving a highly acid residue. This corroded the copper fermenter, and the medium had to be neutralized with soda or calcium carbonate. In a straight fermentation the wort was highly acid for 6 to 8 hours, then turned alkaline, and acidification was necessary for the remainder of the period, usually 6 hours. After some years ammonia became available in cylinders and later in tank cars. It can now be brought to factories in tank cars and in the form of approximately a 25% solution pumped to the fermenters. In certain areas where cane molasses is used, carbamide may be employed. The cane contains sufficient biotin so that the yeast can utilize carbamide. No neutralization is necessary if the urea is decomposed at the proper rate. We also discovered that soya bean urease may be used if the balance is difficult to attain.

An interesting observation was made about twenty years ago in connection with the use of a bios factor, beta alanine, which under certain conditions functions similarly to pantothenic acid as a growth factor for yeast. Asparagine interferes with the utilization of beta alanine, whereas pantothenic acid and asparagine promote normal growth, indicating that there may be interference with the synthesis of pantothenic acid or of coenzyme A. This discovery was helpful in clearing up some of our puzzling experimental results.

Phosphates were available as 16% phosphoric acid and double super 32%. The material was placed in tanks with a suitable amount of water, filtered, and added to the molasses as needed. The arsenic, lead, fluorine, and iron content were often high, and therefore it was desirable to obtain more highly purified materials. After World War I, as previously pointed out, several companies prepared highly purified materials which rapidly replaced the impure grades of phosphates.

It soon became evident to Hildebrandt and me that straight fermentations, which we had brought up to 50% yield or above from the 30-35% obtained by industry, were not the most effective in growing yeast. Usually a 4% molasses solution was prepared, and all the stock yeast, about 3% by weight based on the molasses, and salts were added initially. We began experimenting with high and low concentrations of molasses and yeast. Yields based on the materials were always highest in the low concentrations, often reaching over 80%. We began the continuous and also the intermittent addition of molasses, ammonia, and phosphates to a dilute solution of molasses with a high percent of stock yeast, and, by practicing high aeration under controlled conditions and adding soda or ammonia as neutralizers, were able to increase yields to an astonishing degree.

Unfortunately for us, the work of Hayduck carried on in Germany during World War I and that of Soren Sak in Denmark antedated our work in the United States, and following the treaty of peace, according to the International Convention, the date of application of the Hayduck invention in Germany became the application date in the United States. A United States patent on the use of ammonium sulphate for yeast growing by Neilson and Harrison was also invalidated, as it was anticipated by the Hayduck patents.

The essential features of the Hayduck process involve high dilution, continuous addition of nutrients at an accelerated rate in accordance with the rate of growth, and in amounts just sufficient to supply the needs of the growing yeast, high aeration, and at least 10-20% stock yeast based on the weight of molasses used. No alcohol is produced, and the yields may reach 180-200% of fresh yeast (70% water) based on the sugar used in a fermentation period of 8-10 hours.

This method may be considered one of the most effective contributions of technology to the yeast industry. It is now possible to produce many times the amount of yeast formerly produced in a fermenter in 24 hours. The amount of molasses used per pound is approximately 35-40% of that formerly used to grow a pound of yeast. Up to the present time automatic pH control, temperature control, and the continuous addition of nutrients has been followed. Nitrogen utilization is measured by means of the formol test; phosphates by colorimetric methods. An indication of the importance of this work may be gained by comparing yeast costs of today with those of 1920, keeping in mind the general rise in prices. The price of yeast today is approximately 20% greater than in 1920.

OBTAINING CONTROL OVER FLOURS

One of the serious problems was the determination of the baking quality of yeast. It involved the reaction of yeast in various types of flours and in the presence of various ingredients at levels usually present in doughs. A number of non-dough tests were used experimentally, but each had its limitation. Studies were made covering such factors as dough conditioners, emulsifiers, varying percentages of salt and sugar, softness and hardness of water, and diastatic and proteolytic activity of doughs. Because of the large number of variables involved, it is difficult to duplicate baking tests. The Brabender Farinograph, and Brabender Extensograph, and the Chopin Extensimeter were used successfully. American science and industry are greatly

indebted to the makers of fine instruments, microscopes, cameras, lenses, electrical equipment, and pH instruments. Good instrumentation is one of the fundamental means of making progress in science, and our work became more accurate and experimental work could be repeated as better instruments became available.

The Werner test for determining the quality of flour, as originally designed, failed to give the information needed when used to determine the fermentation rate of yeast or its conditioning effect, because flours often consisted of resistant starch and frequently showed little enzymatic activity. There was not enough sugar present after 1-2 hours of fermentation with a fairly high percentage of yeast to permit the fermentation to continue at its maximum rates. This relation of sugar production from starch to rate of fermentation was overlooked by some workers. The custom of measuring the Lintner value of flours was shown to have little value, for if the liquefying enzyme is absent or present in small amounts and the starch is highly resistant, the saccharifying enzyme present cannot readily convert the starch. Consequently, the amount of liquefied starch converted by the saccharifying enzyme may be limited.

Flours made from wheats harvested by modern methods may be deficient in diastatic activity compared with those made from wheat harvested by traditional methods. The starch may be highly resistant to enzyme attack. In order to overcome this lack of diastatic activity in doughs, a 20°, a 60°, and 120° L malt syrup were manufactured. The 20° malt syrup was designed to apply to all flours and could be used as a safety factor. It would not produce an excess of diastatic activity, and if used in amounts of ½-¼%, would generally provide proper modification of the dough. Blish, Sandstedt, Kneen, Sullivan, Hollenbeck, Bailey, Sherwood, Geddes, Hildebrandt, and Anderson did fundamental work in this field. To obtain better control in this area a great deal of effort was devoted to the development of suitable baking tests. Much of the work was done in cooperation with the Committee on Baking Technology of the American Association of Cereal Chemists.

In 1927 it was definitely recognized that Lintner values when used in doughs were not giving us a measure of the conditioning effect of enzyme preparations. Starch modification bore very little relation to the Lintner value. Jozsa and Gore, and later Johnston and Jozsa, developed a liquefying method which measured the activity of the liquefying enzyme present. Redfern further improved the method. It did not enable us to predict what effect the enzyme would have in various flours because the character of the starch varies with each flour, but it did enable us to standardize all our enzyme preparations for the liquefying factor. The saccharifying (Lintner) factor had been used to standardize malt syrups. Later, Kneen, Hollenbeck, Sandstedt, and Blish developed a simpler method of determining liquefying values than the Jozsa Johnston procedure.

After World War I the use of nonfat milk solids increased rapidly. It was found that bread made by adding nonfat milk solids at 3% levels or more was often coarse in texture and below normal in loaf volume. The gluten did not seem to have proper development. Samples of dry milk were submitted to us. We requested about 56 samples from the largest producers who had kept accurate data on the preparation of each batch from which samples were taken. Our studies and baking tests carried on by J. Freilich were fairly comprehensive.

We found that diastatic malt and dough conditioners added to doughs in suitable amounts tended to improve bread made from poor quality nonfat dry milk. Bailey and Skovholt showed definitely that the diastatic enzymes were inhibited by certain types of nonfat dry milk. The data obtained by this collaborative work enabled the manufacturers of nonfat dry milk to develop a treatment for heating the milk that permitted its wide use without loss of loaf volume.

In this connection I wish to state that the cooperation of the universities whenever approached by the industries was always sincere and friendly. Unfortunately, most of the schools cooperating on milling and baking problems and on nutritional work were limited by the funds available for research, especially during the depression years—1930-1940.

In some flours, in the absence of dough conditioners, the rate of fermentation is affected by the amount and kind of available amino acids present. However, this situation does not occur frequently because dough conditioners are generally employed, and most flours contain some available nitrogenous material.

Active dry yeast, if not properly prepared, will tend to soften doughs and make them sticky. As a result, the loaf volume may be reduced, or the crumb and texture modified unfavorably. The work on oxidants carried on over a period of years at the Mellon Institute by Kohman and Hoffman *et al.*, and at the Fleischmann Laboratories indicated that certain flours could be greatly improved by the use of oxidants. Certain types of active dry yeast are more effective in the presence of oxidants. Flours lacking in gluten quality have been widely studied. The work of Betty Sullivan has been fundamental in contributing to our knowledge in this area.

STRENGTHENING THE "STAFF OF LIFE"

The newer knowledge of nutrition developed by McCollum, Mendel, Sherman, Hart, and others, made a deep impression on some of the younger men in the food industry and on those doing graduate work immediately after World War I. Nutrition studies showed that bread which was formerly regarded as the staff of life had lost by processing several important factors. For various reasons flour had been refined to a point where it could serve only as a supplement to the diet. Should it be restored to its former place? Many students of nutrition and some industrial chemists felt that white bread should be improved by restoring some of the valuable constituents of wheat lost in the milling of the flour.

A large baking company, the Ward Baking Company, in 1923-1924 attempted to make a nutritionally superior bread by utilizing the information on vitamins and proteins which had been recently developed. Bread was made using milk equivalent to the water required to process the dough. Wheat germ extract, malt, calcium salts, a high percentage of fresh yeast for fermentation, and inactive dry yeast for nutritive purposes were incorporated. This bread was able to support rats for generations, and normal reproduction was obtained. Unfortunately, the increased cost of the bread, its slightly different flavor, and the fact that vitamins were not an attractive sales argument at that time made the consumer indifferent to the claims made for the bread, and it was withdrawn from the market. Medical men, also, were not vitally interested in nutrition at this time.

However, in 1932 experiments on improving the B_1 content of yeast showed that a yeast for home baking could be produced that consistently had a level of 150 gamma thiamin per gram. This offered a new approach to the problem of improving bread. Later when Williams et al. developed the structure of B_1, it was found that the two components of B_1, thiazole and pyrimidine, could be readily synthesized by yeast to produce thiamin. It was now possible to make a yeast with 750-800 gamma B_1 per gram. This procedure produced an enriched yeast at low cost. By combining enriched yeast and 6% nonfat dry milk a type of enriched bread was produced. Thus the transition to an enriched type of bread was made without any change in the procedure normally used by the baker.

This enriched bread was more nutritious than, but indistinguishable from, the bread on the market. Many bakers adopted the method during 1939. The researches of Sebrell, Elvehjem, and Spies showed that lack of riboflavin and nicotinic acid were responsible for certain dietary deficiencies that existed in the population. Further additions to enriched yeast were made when nicotinic acid and suitable salts of iron became available. About 120 million pounds of this type of bread were made every month before War Order Number 1 went into effect in 1943. Later riboflavin was produced at prices that made it possible to use it in bread. Because the riboflavin could not be added to

Figure 3. The Fleischmann fermentometer, used in determining the B_1 content of foods.

yeast on account of the color it produced, a color which might be objectionable to bakers, tablets containing enrichment ingredients were made available to the bakers and became widely used. With the addition of nonfat dry milk, B_1, B_2, nicotinic acid, and iron, bread became an effective component of the American diet.

Since 1910 to the present time, there has been a gradual improvement in the nutritive qualities of white bread. The use of more nonfat dry milk, higher percentages of yeast, higher extraction flours, and more recently, enrichment, have been responsible for increasing the nutritive value. There are those who believe it would be desirable to improve bread still further and make it as nearly a complete food as its character permits. There is need, some nutritionists believe, for a basic food that is nearly nutritionally complete, that can be purchased by all economic classes, is available at all times, and is eaten by almost 100% of the population. In the future it may be in the interest of public health to add pantothenic acid, B_6, B_{12}, or some presently undiscovered vitamin. It may be desirable to improve the protein of wheat flour by adding better proteins, such as casein, or by supplementing the proteins by means of amino acids. There is much to learn about the value of the proteins of baked products and the availability of the amino acids. Further studies may indicate whether additional factors should be added to bread. I believe we should have an open mind on this subject and take action in the public interest if circumstances indicate that it is desirable to do so. The present policy seems to be soundly conceived.

Studies indicated that rope might develop in bread from spores of *Bacillus mesentericus* introduced from the flour, dry milk, sugar, malt syrup, or yeast. Years of research were devoted to developing satisfactory procedures for controlling rope in flour, yeast, and malt syrup. At present the baker has very little difficulty with rope as the result of the excellent methods for control developed by a number of laboratories.

Modern bread has to be shipped long distances and is often held in the home for three or four days under unsatisfactory storage conditions, such as high temperature and high humidity. Rope and mold may develop under these conditions.

Mold control is a serious problem to the baker because it involves conditions in the home over which he has no control. However, he is responsible for the sanitary measures carried out daily in his establishment. A number of studies carried out at the Fleischmann Laboratories indicated that the acids of the acetic acid series were effective in control of mold, propionic and butyric being very effective. Hoffman and Dalby arrived at similar conclusions. Small amounts of salts of propionic acid have proved to be very effective in controlling mold in bread, cake, and other baked products. Propionates are also effective in controlling mold on cheese.

The Fleischmann Laboratories found ethylene oxide to be effective in controlling mold. However, bakers are not using this method as the biological, economic, and engineering factors have never been thoroughly investigated by the baking industry. The Griffith Laboratories under the direction of Lloyd Hall have carried on extensive researches on the use of ethylene oxide and made many applications of their work to the control of mold on figs, spices, raisins, et cetera used in baked products. It is not unlikely that many more substances could be found for mold and rope control if extensive research were continued in this field.

The opening of World War II brought us face to face with terrific problems in logistics. Millions of men had to be fed thousands of miles from our shores in lands where civilization was primitive or nonexistent. Our troops were located in countries occupied by hostile troops, and supplies were limited. Bread has been a staple food in the armed forces, but it is not usually available in the front lines. Fresh bread is a morale builder. Fresh yeast is difficult to transport and store, and its high water content, 68-70%, makes it perishable and expensive to ship because cold storage is required. We proposed to supply the armed forces with active dry yeast shortly after World War II began in Europe.

In 1920, as previously stated, experimental work was conducted at the Mellon Institute for the purpose of making a dry yeast equivalent to fresh yeast in fermenting power and in the quality of bread produced. The first successful experiments were carried out on the basis of work which had been recently pursued under Dr. Overton of Wisconsin. It was found that freezing had a strong dehydrating effect on plant cells, an obser-

vation, which, I believe, Czapek in Europe had also made. Using this observation as a basis for the work at the Mellon Institute, we froze yeast cells which had been conditioned in aerated sugar solutions to which small additions of magnesium, potassium, calcium, phosphates, and ammonium tartrate in controlled amounts had been added. Organic extracts of cereals to supply bios factors were added to determine the effect on the stability and rate of fermentation of the dried yeast. The frozen yeast was crushed and ground, raised to 33° F., mixed with dry cornmeal in the amount of ⅔ of its weight, and dehydrated at low temperature from 16-24 hours.

These experiments were successful, and a yeast stable over eight months to a year in sealed containers was obtained. With the better understanding of some of the fundamental factors involved in yeast growth obtained by the study of yeast in synthetic solutions, yeast was conditioned in grain worts, beet molasses, cane molasses, and mixtures of beet and cane. Aeration was carefully studied, and the time, temperature, and humidity of the dehydrating air used in drying were systematically explored. The nutrition and the growing of the yeast was investigated, and the constitution of the finished yeast was carefully followed.

This work was done over a period of many years beginning with the work at the Mellon Institute in which Dr. Hildebrandt was associated. Later A. Shaver, G. Kirby, A. Schultz, and L. Atkin were active in the experimental work. We were able to offer the armed forces a stable active dry yeast, packed in sealed containers, that retained a high degree of activity after more than a year of exposure to the usual temperatures encountered in our climate. Initially, it was about 85-90% as active as its fresh yeast equivalent. The armed forces used this active dry yeast in the Pacific area, Japan, North Africa, Western Europe, and in some of the camps in the United States where personnel changes were frequent and unexpected. Much research is still needed in this field, and many contributions have been made by various manufacturers.

During all our work on yeast, we constantly kept in mind that the quality of yeast and its activity influence bread quality and bread production. Dr. Betty Sullivan devoted many years of research in exploring the effect of reducing substances, such as glutathione, on bread quality. Dry yeast, if not properly conditioned and dehydrated, may develop a strong "reducing action" which is detrimental to good bread making. Factors of this nature were troublesome, and years of work were required to overcome them in the active dry yeast.

The atomic age has given us new tools. As the older epoch closes, we can see encouragement for those in research. The difficult problem of following the intermediate products of metabolism and balancing the end products is being solved by the use of isotopes or tagged atoms. The cycles which have been under study for years are being definitely mapped. We may achieve greater control of enzyme systems and be able to regulate reactions which have been beyond our understanding up to the present. The future offers greater promise than any period heretofore of giving greater knowledge of living processes, better control of growth and yield of food products, and greater control of the factors involved in disease. How to maintain well-being during a long life may well be within the power of men beginning work in the laboratory today.

". . . TO EXAMINE METHODICALLY AND TRULY . . ."

During my years of work in the research fields with which I became associated, I became impressed as I stated previously by the fact that there was seldom sufficient fundamental knowledge available to meet our needs and to enable us to proceed with our development. I hope that management will gradually see the need of doing more fundamental work in industrial laboratories and of supporting long range fundamental research in universities. For many years I kept on my desk this little statement from Marcus Aurelius which, I believe, should encourage those whose activities are too greatly inhibited or circumscribed: "Nothing is so productive of elevation of mind as to be able to examine methodically and truly every object which is presented in life."

Our individual contributions may be insignificant, but we shall have served if we have created an atmosphere where science can flourish and if we have enabled others to carry on. Advances in science are won by cooperation and by the contributions of many minds, and all must be conditioned by an atmosphere that permits freedom of thought and action. Science cannot flourish in every society. Those of us who have lived and worked in the first half of the century are grateful that we had the environment created by a free society to work in our chosen fields of science.[4] I am sure you will agree that science is the greatest intellectual adventure of our age. As S. H. Tizard in his A. D. Little lecture, 1952, stated, "Its pursuit stimulates the highest faculty of the mind, and its discoveries satisfy the soul in search of beauty."

Recently Dr. Butterfield of Cambridge University wrote, "The scientific revolution we see today outshines anything since the rise of Christianity and reduces the Renaissance and Reformation to the rank of a mere episode. It looms so large as the real origin of the modern world and of the modern mentality that our customary periodization of European history becomes an anachronism and an encumbrance."

We revert to Dr. Prescott again. One of the thoughts so well expressed in his profound and beautiful commencement address given at the Massachusetts Institute of Technology in 1942 is this reference to the Latin inscription in the president's office: "Alia initia e fine" —"Other beginnings arise from each ending." We have seen the end of one scientific era. Let us hope that other beginnings will arise in this atomic age which will expand man's horizon and usher in an epoch of enlightment where science can truly serve man.

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[4] Science does not reach into an infinite past, and we do not know its future. We do not understand the world and the universe. Whatever science finds contributes to the understanding of things and people. It gives a surer approach to knowledge, a wider field of vision, and an added appreciation of all things.

Effect of Drying Conditions on Moisture Retention and Density of Dehydrated Peas[a,b,c]

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During the drying of peas in a conventional air-dryer, there is a continuous retardation of the rate and drying practically stops before the water is completely removed. Any effect which causes a speeding-up of the drying rate also results in a lower moisture level in the final air-dried product. The retardation in drying rate is not observed if fresh frozen peas are dried under vacuum. When peas are partially dried under vacuum and partially dried in air, the drying will remain incomplete regardless of whether the air-drying stage takes place before or after the vacuum-drying stage. The retardation of the drying rate is associated with shrinkage and an increased density of the dehydrated peas.

As a result of an extensive research program during World War II much was learned about better methods of dehydrating vegetables, but difficulties were encountered in maintaining good quality in the dried materials under conditions of high temperature storage. Toward the end of the war the importance of low moisture content in prolonging the storage life of dehydrated vegetables was recognized. Howard *(6)* demonstrated the possibilities of achieving the necessary low moisture content by packaging the dried material with a suitable desiccant.

More recently the New York State Agricultural Experiment Station in cooperation with the Quartermaster Corps has investigated the possibilities of dehydrating green peas, a vegetable not dehydrated on any large scale during World War II. In the course of these studies it has become apparent that a low residual moisture content is imperative if the dehydrated peas are to retain their quality during storage.

When peas were dried to moisture levels of two to ten percent, and then subjected to stability tests at elevated temperatures for extended periods, it was apparent that the extent of deterioration in storage depended on the moisture level *(5)*. Conventional air drying at higher temperatures if continued down to the point of sufficiently low moisture content to assure proper storage stability, resulted in damage to color, texture, rehydration capacity and in excessive browning. Consequently some other method (or combination of methods) of drying had to be utilized in order to achieve the low moisture content so important to the retention of good quality in dehydrated peas.

The present paper deals with some of the factors which influence the rate of drying and the final moisture level when peas are dehydrated under various conditions.

MATERIALS AND METHODS

The peas used in this study were grown under controlled conditions on Experiment Station plots. All of the raw material was graded, blanched, dehydrated and packed in pilot plant equipment under conditions simulating a commercial operation. Peas were blanched in water at 210° F. (99° C.) for one minute.

Both air and vacuum drying procedures were used to assess the factors limiting the attainment of a low moisture content in dehydrated peas. Air drying was accomplished in a small experimental dehydrator wherein the air flowed across the surface of a series of wire mesh trays at a velocity of 900 to 1000 feet per minute. The temperature and humidity of the air stream was maintained by a recording-controlling hygrometer which activated the fuel supply valve and the motor on the intake and exhaust dampers. At the beginning of the drying period when the heating capacity of the dehydrator was taxed, the damper control had to be manually operated. The trays were arranged in a carrier supported on a scale outside the dehydrator so that the weight of the product might be determined at 15-minute intervals without disturbing the drying conditions. From these weighings the rate of dehydration has been calculated in terms of percent change in weight using the original wet weight as a basis.

With this unit it was possible to observe drying rates and changes in quality over periods of twenty minutes to four hours and in temperatures ranging from 250° F. to 120° F. (121° C. to 49° C.), with variations in relative humidity of seven to sixty percent. Vacuum drying was carried out in a Stokes cabinet type freeze-drying unit under pressures ranging from 90 to 140 microns with the heated plates at 100° F. (37.8° C.). The dehydrated peas were stored either in No. 2 cans or in 30 pound tins at 33° F. (0.6° C.) until used.

Moisture content of the materials used in this study was determined in a vacuum oven at 158° F. (70° C.) by the standard A.O.A.C. method *(1)*.

Density was determined by weighing a measured volume of dried peas. Because of the practical importance of density in connection with transportation costs, the values for density have been expressed in this paper in pounds per cubic foot.

RESULTS AND DISCUSSION

When peas are dried in the conventional air dryer, as the drying proceeds there is a continuous retardation of the rate, and drying practically stops before the water is completely removed *(3)*. With an adequate air velocity the drying rate and the final moisture content of the air dried product are governed largely by the drying temperature, particle size, and relative humidity.

The effect of drying temperature on the rate of drying of peas is shown in Figure 1. Tenex peas, size 4, with a tenderometer reading of 104, were dried in the

[a] Presented at the Boston meeting of the Institute of Food Technologists, June 24, 1953.

[b] This paper reports research undertaken in cooperation with the Quartermaster Food and Container Institute for the Armed Forces, and has been assigned number 510 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsement of the Department of Defense.

[c] Journal Paper No. 979, New York State Agricultural Experiment Station, Cornell University, Geneva, New York.

air dryer to constant weight loss at four different dry bulb temperatures. Changes in weight were observed at regular intervals throughout the period of drying. The higher temperatures gave not only a faster rate of drying, but also resulted in a lower final moisture content.

The particle size of the material being dehydrated also plays an important role in determining the rate of drying and the final moisture content of the product after drying. When three different size grades of Tenex peas from the same lot were dried at 200° F. (93° C.) (dry bulb), the smaller sized peas dried faster and to a lower residual moisture content than the large peas (Figure 2).

The relative humidity of the air in the dryer exerts an effect on the rate of drying of peas. Thomas Laxton peas, size 4, tenderometer 90, were dried at 200° F.

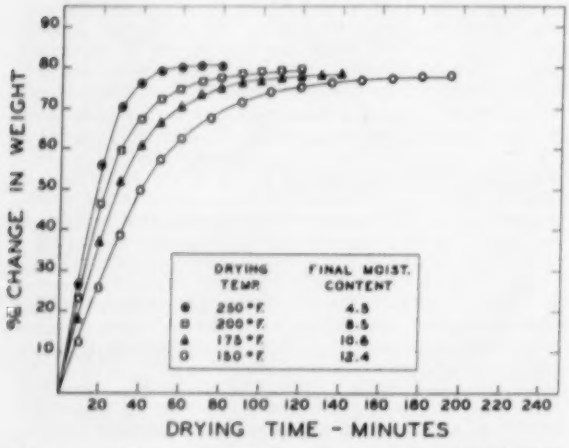

Figure 1. Effect of temperature on the drying rate of peas.

Variety, Tenex; Size grade 4; Tenderometer 104; Dry bulb temperatures, 250°, 200°, 175°, 150° F.; Wet bulb temperatures, 105.5°, 98.5°, 94°, 90° F.

(93° C.) (dry bulb) and at three different relative humidities; 57%, 39% and 22% (Figure 3). The peas dried most rapidly at the lower relative humidity and more slowly as the relative humidity of the air was increased. The final moisture content of the peas varied from 9.7 to 11.3% depending on the relative humidity.

Figures 1, 2, and 3 show the manner in which temperature, particle size and relative humidity influenced the rate of drying of peas in a conventional, cross circulation air dryer. It is evident that any effect which caused a slowing down of the drying rate also resulted in a higher moisture level in the final air dried product.

The retardation of drying rate which is characteristic of air drying is not apparent if fresh frozen peas are dried under vacuum. Frozen peas can be dried *in vacuo* to a moisture content of less than one percent with no apparent damage to the quality of the product *(2, 4)*.

Since freeze-drying is slow and expensive, it was decided to partially dehydrate the peas in a conventional air dryer and complete the final stage of drying in a freeze-dryer. It was thought that by this procedure light could be shed on the reasons for incomplete drying in the conventional air dryer. Frozen samples of blanched Perfected Freezer peas, size 5, tenderometer 120, were thawed at room temperature and then air dried at 200° F. (93° C.) for different inter-

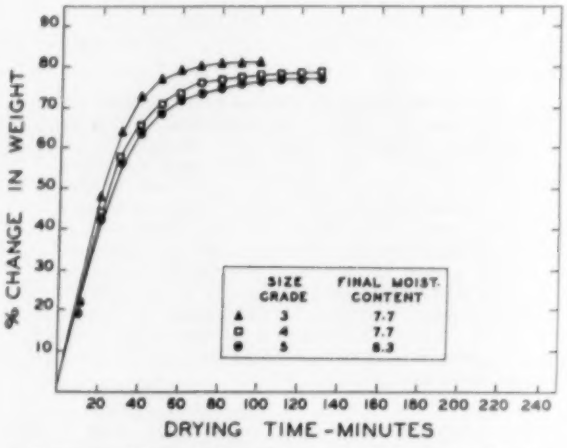

Figure 2. Effect of size grade on the drying rate of peas.

Variety, Tenex; Size grade 3, 4, 5; Tenderometer, 95, 105, 118; Dry bulb temperature, 200° F.; Wet bulb temperature, 98.5° F.

vals of time up to 100 minutes, refrozen and then placed in the Stokes freeze-drying unit for removal of the remaining moisture (Figure 4, Table 1). When the final moisture content of the peas after vacuum drying was plotted against time in the air dryer, it was apparent that even short exposures of peas to heated air would prevent subsequent complete drying of the whole peas. The longer the peas were air dried prior to vacuum drying, the higher was the residual moisture content in the final product.

The precise nature of the changes brought about in

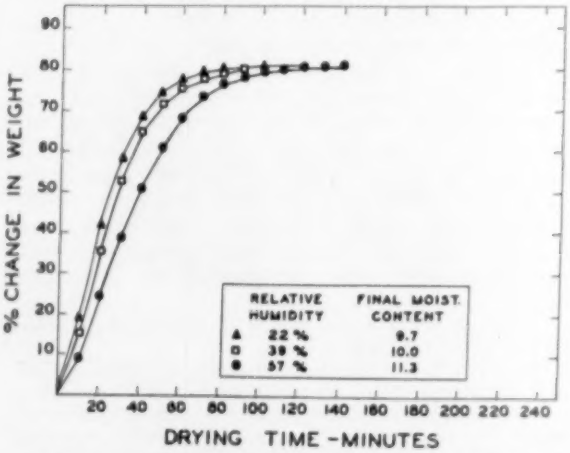

Figure 3. Effect of relative humidity on the drying rate of peas.

Variety, Thomas Laxton; Size grade 4; Tenderometer, 90; Dry bulb temperature, 200° F.; Wet bulb temperatures, 140°, 160°, 175° F.

the whole peas by the preliminary air drying is not understood at the present time. According to Ede *(4)* the loss of water vapor from a pea may occur through the development of a relatively high pressure in the interior and passage through the outer layers of pea

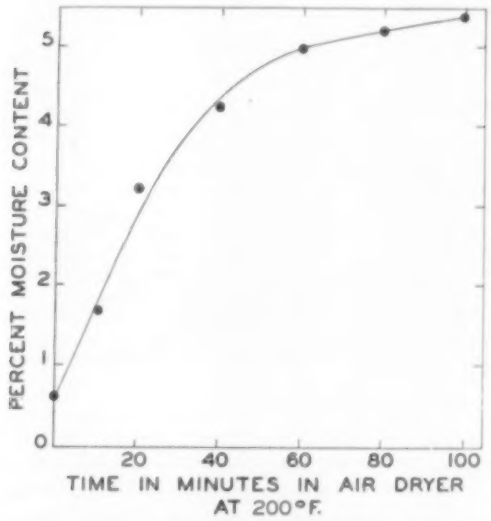

Figure 4. Effect of preliminary air drying on moisture content of vacuum dried peas.

Variety, Perfected Freezer; Size grade 5; Tenderometer, 120; Dry bulb temperature, 200° F.; Wet bulb temperature, 98.5° F.; Stokes dryer plates at 100° F.; Time in vacuum dryer, 48 hours.

tissue to the surrounding atmosphere. In the present study it seemed likely that during air drying changes in the permeability of the peas to passage of water vapor occurred, and "case hardening" of the exterior surface of the peas was produced. Prolonged exposure of peas to heated air may have produced a condition of impermeability to passage of water vapor before drying was complete. The impermeability thus produced resulted in an entrapment of water vapor within the peas, and hence, in less complete drying and a higher residual moisture content.

Since preliminary air drying prior to vacuum drying did not produce sufficiently low moisture contents, an experiment was conducted to determine the effect of air drying after a preliminary stage of freeze-drying. Frozen blanched Perfected Freezer peas, size 4, tenderometer 122, were placed in the freeze-dryer for different intervals of time up to 16 hours, after which they were subjected to 3 hours of drying at 150° F. (66° C.) in the air dryer (Figure 5, Table 2). Preliminary vacuum drying was beneficial in that it favored a lower final moisture content than was obtained with air drying. The longer the product was in the vacuum dryer, the greater was the beneficial effect of vacuum drying. It is clear that during the final stage of air drying after preliminary vacuum drying a retardation effect was produced.

TABLE 1
Effect of preliminary air drying on subsequent vacuum drying of peas

Time in air dryer at 200° F. (minutes)	Percent moisture	
	After air drying	After vacuum drying (48 hrs. with plates at 100° F.)
0	76.0	0.6
10		1.7
20	56.6	3.2
40	39.7	4.5
60	23.4	5.0
80	17.3	5.2
100	11.5	5.4

TABLE 2
Effect of preliminary vacuum drying on subsequent air drying of peas

Time in Stokes Dryer (hours)	Percent moisture		
	After vacuum drying (plates at 100° F.)	After air drying (3 hrs. at 150° F.)	After bin drying (48 hrs. at 120° F.)
0	78.4	10.2	4.3
0.5	73.7	8.8	3.2
1	71.8	8.0	3.3
2	68.2	7.1	3.2
4	61.1	6.4	2.9
8	20.1	4.6	2.5
16	3.2	2.1	1.6

The retarding effect of air drying was thus evident both in the early and later stages of drying. To account for the fact that there was no retardation effect during freeze-drying it may be assumed that the exterior of the pea remained permeable. The experimental observation that there was less shrinkage of the skins during freeze-drying than occurred during air drying supports this assumption. A pea in such condition would be quite amenable to further drying, either by vacuum drying or by air drying, as long as there is no barrier at the surface of the material impermeable to the passage of water vapor.

There was a direct relationship between the density of the dehydrated peas and their moisture content after

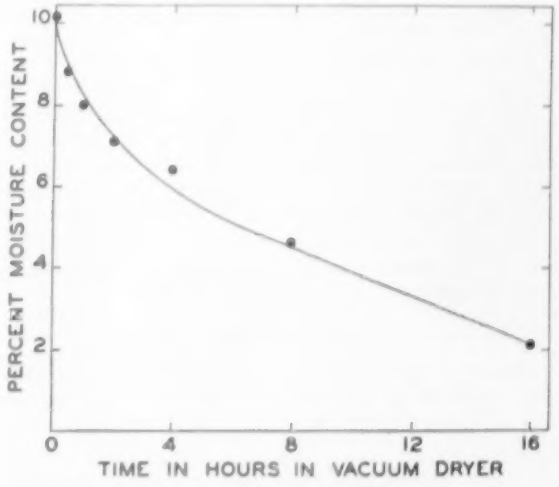

Figure 5. Effect of preliminary vacuum drying on moisture content of air dried peas.

Variety, Perfected Freezer; Size grade 4; Tenderometer, 122; Dry bulb temperature, 150° F.; No wet bulb cam used; Stokes dryer plates at 100° F.; Time in air dryer, 3 hours.

dehydration. Whether the preliminary drying was done either in the vacuum dryer or in the air dryer, when the final moisture content of the dehydrated peas was lower, the density of the product was decreased. Figures 6 and 7 show the effects of varying degrees of preliminary vacuum and air drying on the density of the final dried product.

A further reduction in moisture content following vacuum drying or air drying can be achieved by exposure of the peas to desiccated air in a bin. It appears likely that under commercial conditions the later stages of drying would probably be completed in a bin dryer. For this reason the peas dehydrated as outlined above were bin dried for 48 hours at 120° F. (49° C.) in a small experimental bin dryer. By various combinations of vacuum drying, air drying, and bin drying, peas of less than 4% moisture can be produced as shown in Table 2.

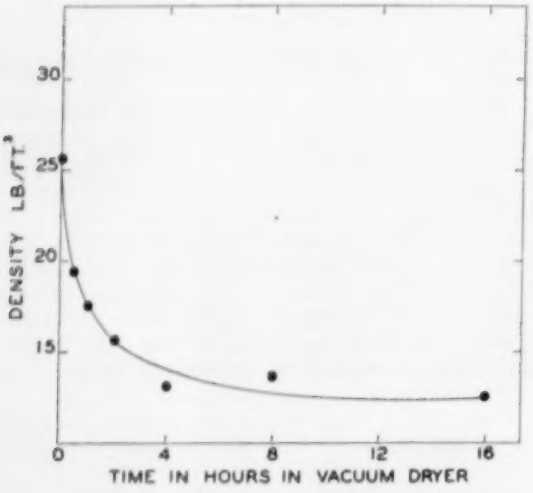

Figure 6. Effect of preliminary vacuum drying on density of air dried peas.

Conditions: Same as for Figure 5.

Under practical conditions a short period of air drying with an intermediate stage of vacuum drying might still prove to be most effective in obtaining a product of low moisture content. This work is being continued with the object of working out the best combination of preliminary air drying, or vacuum drying with final air drying and bin drying in order to give a final product of good quality and low moisture content.

CONCLUSIONS

Conventional air drying under a variety of conditions failed to produce dehydrated peas of satisfactory low moisture content without causing damage to the product.

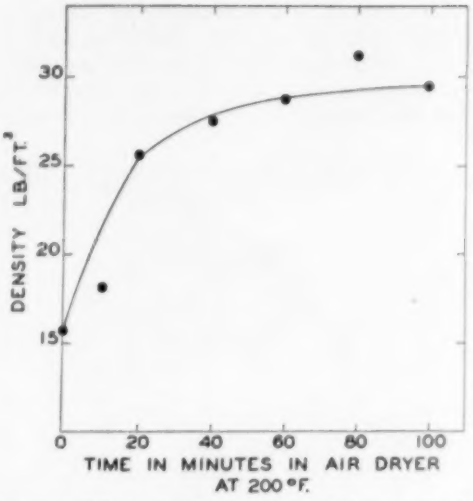

Figure 7. Effect of preliminary air drying on density of vacuum dried peas.

Conditions: Same as for Figure 4.

During air drying any effect which tended to slow down the rate of drying of peas resulted in a higher residual moisture content in the finished product. Vacuum drying of peas produced a product of low moisture content.

When peas were subjected to a combination of air drying and vacuum drying even short periods of air drying prevented the attainment of a final low moisture content.

Any combination of drying conditions giving a lower final moisture content was associated with a decreased density of the peas.

The results suggest that a combination of drying methods will probably be required in order to produce dehydrated peas of low moisture content under practical conditions.

LITERATURE CITED

1. Association of Official Agricultural Chemists. *Official and Tentative Methods of Analysis.* 6th Ed., 1945, 932 pp.
2. Barker, J., Gane, R., and Mapson, L. W. The quality of green peas dried in the frozen state. *Food Manuf.*, **21**, 345 (1946).
3. Caldwell, J. S., Culpepper, C. W., Ezell, B. D., Wilcox, M. S., and Hutchins, M. C. The dehydration of peas. *Canner*, **103**, No. 13, 13, No. 14, 30, No. 15, 20 (1946).
4. Ede, A. J. The low-temperature vacuum drying process as applied to green peas. Part II. *J. Soc. Chem. Ind.*, London, **68**, 336 (1949).
5. Hand, D. B., Wagenknecht, A. C., Moyer, J. C., and Robinson, W. B. (Unpublished data.)
6. Howard, L. B. Factors of processing and storage which affect quality in dehydrated vegetables. *Proc. Fourth Annual Meeting*, National Dehydrators Assoc., Chicago, 17 (1945).

Factors Affecting the Texture of Rehydrated Potato Granules[a,b]

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The effect of the various steps in the add-back manufacturing process on texture of rehydrated granules was studied. Conditions of cooking, mashing, mixing, aging, and drying affected the amount of cell breakage during processing and consequently the texture of reconstituted material. Differences in the appearance and manner of water resumption of two widely different samples are described. Improvement of texture was noted on addition of glycerol monolaurate during the mixing step.

Potato granules are a dehydrated product consisting of singe intact cells and cell agglomerates. The granulation or separation of the cells is usually accomplished by mixing previously dried powder with cooked potato to bring the over-all moisture content to 35 to 40%. The mixing serves to lower the moisture content of the cooked potato to a point where it is no longer adhesive and the cells can be separated without breakage. After a standing period, during which complete moisture equilibration takes place, the damp powder is given a second mix and dried in suspension in a stream of heated air. The equipment used at these laboratories has been described in detail *(1)*.

Potato granules, if properly made, have several advantages over other types of dehydrated potatoes. They have high bulk density and thus conserve shipping space. They are a fully cooked product and may be rehydrated for use by the addition of hot water. They are dried very rapidly. Even though the powder is recycled many times in the mixback drying process, the total time in the drying atmosphere is much less than that of potatoes in other dehydration processes. Less damage due to heat is therefore sustained.

A disadvantage is the recycling of a large proportion of the product for use as the granulating agent. Approximately 12 to 18% of new dry solids are added to the process during each cycle. This may result in cumulative damage. If, by mishap, improper conditions are used on one cycle, the product of many cycles may be damaged. A considerable amount of new material must then be added in diluting out the damaged material. Likewise, the change in quality of the raw material is not determined until a considerable amount of new material is produced. It is very important in producing potato granules that the process be closely controlled at all times and complete records be kept of conditions during processing.

PROCESSING VARIABLES

In the processing of potato granules, good texture has been very difficult to attain. The texture of the reconstituted granules should be mealy. The product should be tolerant to a wide range of water temperatures on reconstitution. It should absorb the water slowly enough so that a uniform mix can be obtained, but not so slowly that further thickening takes place on standing. In the usual method of preparing granules, 4 parts by weight of fluid are heated to 180° F. and one part by weight of granules whipped in by means of a fork or a mixer. It is advantageous to have granules of such nature that they can be reconstituted in water up to the boiling temperature. They can then be served hotter. A product having a wider range of tolerance to water temperature is also easier for the cook to prepare. Most of the potato granules prepared at the present time become pasty if reconstituted at temperatures above 180° F., and one of the objectives of this research was to determine the factors affecting texture and means of improving it.

The physical and chemical nature of the potato cells are affected by conditions during each step of the processing from the cooking to the drying step. A further complication is that certain processing variables are dependent upon other steps in the process and so must be radically changed to become compatible when another step in the process is varied.

Cooking. In the present study, whole potatoes were steam cooked at atmospheric pressure on trays. It was found that overcooking was quite detrimental to good texture. Potatoes which were peeled and which were exposed to condensate from the top of the cooker had much poorer texture and were difficult to granulate. Much better texture was obtained when washed, unpeeled potatoes were cooked. It was noticed, however, that the color of the resulting granules from unpeeled potatoes was darker than that of peeled potatoes. The unpeeled potatoes granulated better, and there was less 14- to 65-mesh material in the dried product. This was a decided advantage since coarse material because of its slow rate of drying is more easily heat damaged.

Since only material passing a 65-mesh screen is taken off as product, the 14- to 65-mesh material is always recycled, subjecting it to cumulative heat damage. This material must eventually be discarded if not broken down, thus impairing the economics of the process.

Mashing. After cooking, the potatoes may be mashed before mixing with dry material for granulation or the potatoes may be mixed and mashed in the same operation. In large scale operations, it has been found advantageous to mash between rolls set with a clearance of about 1/16 inch. Smooth rolls with a diameter of 24 inches will "nip" whole potatoes and do an efficient job of mashing. In the present study, roll mashing was not found to be practical for small batches. The rolls did not become heated, the material tended to "ride" on the rolls, and considerable cell damage took place. Condensation on the rolls from the steam in the potatoes caused considerable slippage and

[a] This paper reports research undertaken in cooperation with the Quartermaster Food and Container Institute for the Armed Forces, and has been assigned number 503 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsement of the Department of Defense.

[b] Presented at the Fourteenth Annual Meeting of the IFT, Los Angeles, California, June 29, 1954.

abrasion, and the potatoes were cooled by contact with the cold rolls. Excessive cooling before mashing caused case hardening, increasing the amount of oversize material produced.

Mixing and aging. It has been found necessary to employ 2 mixing periods separated by an aging period to attain proper granulation. In batch runs, a planetary food mixer was used; in continuous runs, a 6-inch conveyor having a central shaft fitted with paddle mixing blades served as a mixer. The aging period apparently served to allow moisture to equalize between wet and dry material, but this equalization was inadequate unless the preliminary mixing was thorough. If the second mixing period was eliminated, coarsening again occurred—perhaps because a certain amount of adherence between cells took place during the equalization. It was necessary to use great care to make sure that the mix was thoroughly cooled during aging to assure proper breakdown in the second mix. The amount of cooling was more important to proper granulation than the time of aging, suggesting that cooling was at least as important as moisture equalization in the aging step. It has been demonstrated many times that if the material is not at room temperature or below after aging, the amount of coarse material immediately rises.

The technique employed in mixing was greatly influenced by the rate of absorption of water by the dry seed material. A drier seed material proved slower to absorb the moisture, as did a coarser powder. The slower the moisture absorption by the powder, the gentler the mixing action necessary. The cooked material at high moisture was fragile and easily damaged. Water should be removed rapidly by the dry powder to increase the resistance of the cells to mechanical breakage. On the other hand, when an appreciable portion of the moisture of the wet material was lost before the cells were thoroughly separated, they could then be separated only with great difficulty. These cell aggregates tended to remain intact and were easily heat damaged in drying. The mixing efficiency of the mixer had its effect on the required mixing time. The small planetary mixer required less mixing than the larger continuous mixer.

Drying. The rate of drying of the damp powder determines its final bulk density and color and the characteristics of the reconstituted product. Pneumatic drying, or entrainment of the powder in a heated stream of air, provides the necessary drying conditions. The drying system used in the present study (Figure 1) consisted of 53 feet of vertical 8-inch duct, a constriction to 5 inches where the powder was introduced, and a cyclone dust collector for removal of the dried powder from the air stream. This system had the advantage of simplicity, but in the type of cyclone collector used in this study, there was a tendency of the coarser particles to be held in the air stream. This resulted in scorching due to longer exposure to the high temperatures. At the lower air velocities, because of faster drop out of coarse material, scorching was not so noticeable.

The centrifugal action in a cyclone is damaging to the potato granules. In a set of experiments in which the damp powder was introduced at the entrance to the cyclone, eliminating the passage through the air duct, the cell damage was sufficient to make the product pasty on reconstitution. Since the air velocity was not higher than that used when the material was dried in a duct and removed by the cyclone, it was concluded that the centrifugal action on the powder, while it was in the damp fragile condition, resulted in the damage. Some damage undoubtedly occurred in the cyclone in the duct system. This was minimized, however, by low air velocities and by the fact that the powder was quite dry by the time it reached the cyclone.

A drying system has been designed *(2)* in which the abrasion has been minimized. In this system no cyclone collector is employed to remove the dry powder from the air stream.

Better texture in the product was obtained when drying at 300° than at 250° F. Much higher temperatures (600° F.) resulted in puffing of a large proportion of the cells. These were quite fragile and could not be used as mixback material.

Rapid drying was advantageous in preventing heat damage in the powder. Since abrasion damage was greater at higher moisture contents, as discussed above, this damage should be decreased by faster drying rates. The rate of drying was determined by the moisture content of the powder and by the temperature and velocity of the air stream.

The air velocity in the pneumatic drying system was of great importance. Data presented in a previous paper *(1)* show that at an air velocity of 73 feet per second, excessive cell breakage

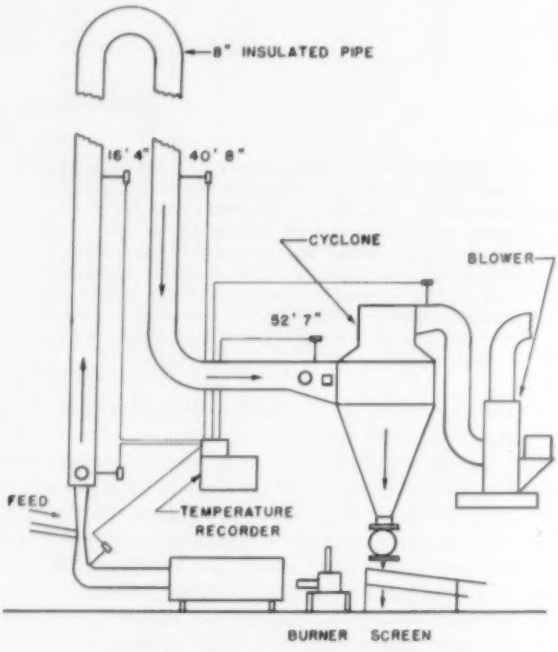

Figure 1. Diagram of drying system.

took place, but at an air velocity of 41 feet per second, the cell damage was slight in samples put through the pneumatic drying system ten times in succession. This indicated that the lowest feasible air velocity that will carry the material through the system should be used. Since the moisture content of the material decreased with each successive cycle, moisture content is a function of the number of cycles, as was shown in the previous paper. It was also shown that the greatest cell damage occurred at the highest moisture content of the damp powder.

To minimize cell breakage, a low air velocity in the drying duct was used, the current system being operated at about 30 feet per second. At these low air velocities, there was danger of material dropping down against the air stream at the point of introduction of the mix, and subsequent burning of the material. To minimize this possibility, the feed was introduced to the dryer into a constricted section (5 in. diameter as compared to 8 in. duct diameter in the dryer). Thus, the air velocity was considerably higher at this point than in the rest of the drying duct. This higher velocity should also facilitate the separation of the cells in the drying step.

PHYSICAL CHARACTERISTICS AND THEIR EVALUATION

Of the factors affecting the texture of reconstituted granules, one of the most intensively investigated has been the amount of extracellular starch. It was believed at the outset that pastiness and poor texture were primarily due to breakage of cells in processing, freeing starch to give a gummy texture to the product. It has been found, however, that cell breakage is not the only

factor affecting texture. Samples of comparable broken cell content may have widely different texture depending on the physical character of the granules. It appears that more significant than broken cell content of the dry material is the susceptibility of this material to cell damage on reconstitution. The investigators are of the opinion that actually more cells are broken when the material is reconstituted than during the processing. Processing, however, markedly affects the susceptibility to cell damage during reconstitution.

The rate of absorption of water in reconstitution appears to be of great importance in determining texture. Poor texture is often associated with rapid regain of water. Samples which have been found best in texture and which show the lowest free starch content on reconstitution have been those which took the longest time for absorption of the moisture.

The extent to which the cells shrink affects the final texture. Those samples consisting largely of cells which showed a large difference between the cell size of the dried and reconstituted products had poorer texture than samples showing little swelling of cells on reconstitution. This factor in turn seems to be controlled by the rate of temperature of drying in the pneumatic system. Samples dried at higher temperatures (300° F. and up) gave better texture than those dried at 250° F. and showed less cell shrinkage on drying. The pH of the water of reconstitution also affects texture, a more alkaline water giving a poorer texture *(1)*.

The extracellular starch in the rehydrated product may be present as a result of damage during processing or damage during reconstitution. One of the shortcomings of the analytical test for free starch *(1)* is that it does not measure the susceptibility of the granules to breakage during reconstitution. Two products which showed approximately the same amount of extracellular starch by the iodine method *(1)* but which on reconstitution had very different texture characteristics were examined under the microscope at a magnification of 70X. (In the reproductions shown in Figures 2-9, magnification is 50X. due to reduction.) Product A, a commercial sample, which was known to have a very good texture even when reconstituted in boiling water, was compared with product B, a laboratory sample, which became quite pasty when reconstituted in water at 180° F.

A study of these two materials under the binocular microscope showed that product A in the dried state had an average cell size which was more than double that of product B. In addition, many of the cells of product A had been puffed in drying and were hollow. When these absorbed water, the starch swelled inwardly and filled the hollow portion. Many of these cells were open, and as the starch swelled, the air was forced out through these small openings. Product B swelled outwardly; when the starch was stained with iodine, it could be observed that the cell wall swelled faster and to a greater degree than the intracellular starch. Mechanical stirring of product A had little effect upon it; but in product B, the intracellular starch shelled out of the cell wall quite easily. Even when the cells of product A were crushed, there was no observed separation of cell walls from the starch therein.

Figures 2 and 3 of products A and B, respectively, at the same magnification show the difference in appearance of the dry material. Product A shows puffed, rounded cells appearing very much like a spray dried product. This effect can be produced during very rapid

Figure 2. Product A, dry material.

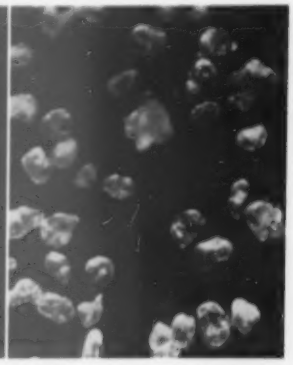

Figure 3. Product B, dry material.

drying at high temperatures. The cell is prevented from shrinking and may even swell due to rapid vaporization of water in the interior. Product B was dried slowly and showed none of these "puffed" cells.

Figures 4 and 5 show products A and B, respectively, during the absorption of water. Product B takes up water extremely rapidly with considerable swelling. Product A does not increase greatly in cell size upon absorbing water. The swelling of the starch takes place by filling of the hollow portion of the cell. Air bubbles may be seen in a large proportion of the cells. As water absorption continues, these are forced out through

Figure 4. Product A, absorbing water.

Figure 5. Product B, absorbing water.

openings in the cell walls. Even though there are cell wall openings, the starch remains within the cells and the texture is not adversely affected.

Figures 6 and 7 show products A and B, respectively, after moisture absorption is completed and cells are stained with iodine. It will be noted that cells of product

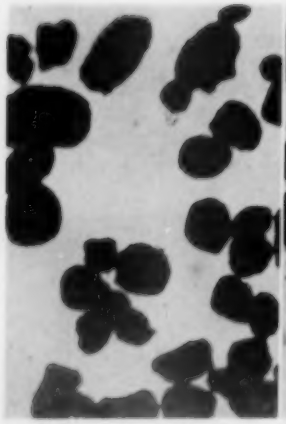

Figure 6. Product A, after staining.

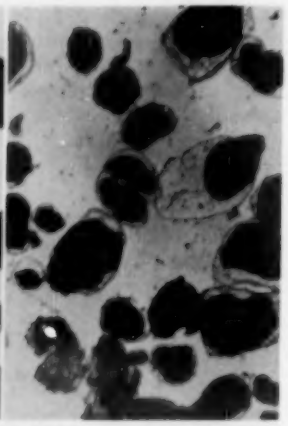

Figure 7. Product B, after staining.

A are completely filled with starch, whereas many cells of product B have swelled and are only partly filled with starch.

Figures 8 and 9, respectively, show product A after severe mechanical abrasion and product B after less severe breakage. No separation of cell wall from starch can be seen in A, but many cell walls, which have been loosened and separated from the starch, are visible in product B.

Considerable effort has been expanded at these laboratories on a method for evaluation of texture by determination of the viscosity of reconstituted samples. This procedure, described in detail in a previous paper *(1)*, consists in careful preparation of a uniform sample of reconstituted product of a definite moisture content and at a definite temperature, and subsequent determination of its viscosity with a Brookfield Synchro-lectric

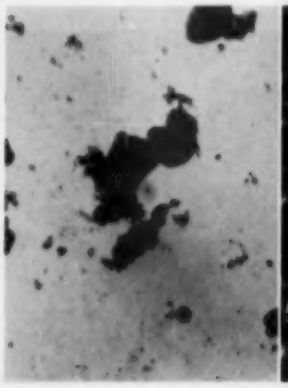

Figure 8. Product A, after abrasion.

Figure 9. Product B, after abrasion.

Viscometer in conjunction with a Brookfield Helipath Stand. Viscosity is determined from the torque on a rotating T-shaped spindle, and the helipath stand lowers the rotating spindle at a constant rate into the material, thus placing always fresh material in the path of the spindle.

The conclusion was advanced in the previous paper *(1)* that the value of the peak viscosity is of little significance in comparing samples from different sources. The significant property is the shape of the viscosity-reconstitution temperature curve. Samples which showed a viscosity peak at a low temperature of reconstitution were found to be pasty and poor in texture. This property has been correlated to some extent with broken cell content. An ideal sample would be expected to show a viscosity maximum at a high temperature and to have a broad peak.

Examination of Figure 10 will show extremes in viscosity profiles that have been found in laboratory samples made here. Sample A, an older product, was found on reconstitution to give a poor, pasty texture. Samples B, C, and D had good texture, and show a continuous increase in viscosity with increasing recon-

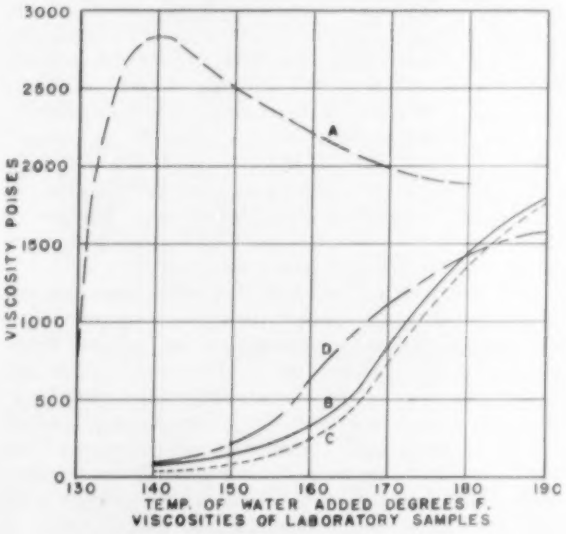

Figure 10

stitution temperature. Samples B and C were treated with 0.25% and 0.50% glycerol monolaurate, respectively, and showed the best texture when reconstituted.

The differences in processing technique between Sample A and the others include the following: (a) The potatoes for Sample A were peeled and mashed before mixing; the others were not peeled and were mashed during mixing, for reasons mentioned in the discussion of the cooking step. (b) Sample A was dried at 250° F., the others at 300° F. (c) Sample A was aged 45 minutes, the others one hour. In the later runs, great care was taken that the samples were cooled to room temperature or below before drying. (d) The moisture content of the damp powder immediately before drying for Sample A was 37%; for the others, 42%.

The viscosity profiles of several commercial samples are compared with Sample B from this laboratory in Figure 11. Sample E gave poor texture on reconstitution, as evidenced by the low temperature of maximum

viscosity. Samples F and G both gave good texture, Sample G having the best quality at high water temperature.

Glycerol monolaurate. The effect of the use of glycerol monolaurate as an addition agent during the processing was studied with encouraging results. Samples B and C of Figure 10 contain 0.25% and 0.50% (dry basis), respectively, of glycerol monolaurate. This material introduced no difficulties in processing and was successfully processed at 43% mixback moisture in the batch process. It was added as a water suspension during the first mix. The color and flavor of reconstituted product were as good as that of the control sample (D). The treated samples could be reconstituted at 180°, and showed the best texture and mealiness of any materials yet produced at these laboratories.

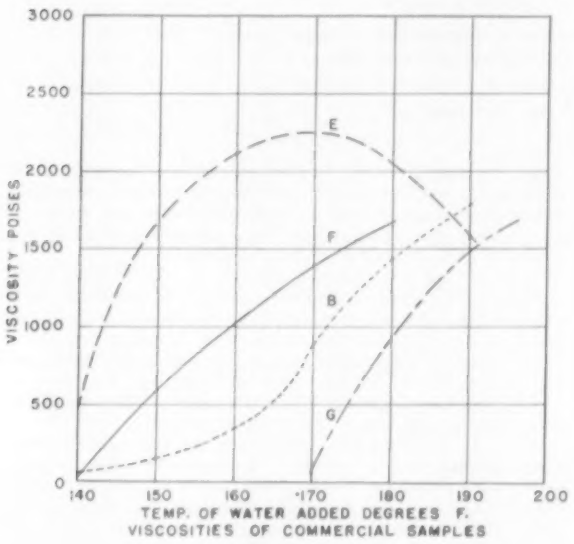

Figure 11

A clue to the action of glycerol monolaurate might be found in the behavior of such substances toward the linear A-fraction of the starch, which has been stated to be the primary cause of pasty texture. In reference to separation of starch fractions, Schoch *(3)* says, " . . . when a starch sol is treated with polar organic substances containing a hydrophilic group (such as hydroxyl or carboxyl) attached to a hydrophobic residue, the A-fraction adsorbs this material by polar attraction for the hydrophilic group. The resulting absorption complex is insoluble by reason of its hydrophobic leading and consequently separates from solution."

SUMMARY

Effect of certain operating variables on the texture of reconstituted potato granules is given. Overcooking affected texture adversely, but cooking without peeling was beneficial. The mixing equipment and speed of mixing must be chosen carefully to be compatible with the rate of moisture exchange between recycle granules and freshly mashed potatoes. Cooling of the mix during the aging step is essential to fine granulation. High rates of drying improve texture, but very high air temperatures give poor texture. High air velocities cause cell breakage in the pneumatic drying, the damage being greatest when the moisture content of the powder is highest.

Alkalinity of reconstitution water affected texture, lower pH giving better texture. The shape of the viscosity-reconstitution temperature curve was indicative of the manner in which a sample will reconstitute. Glycerol monolaurate gave much improved texture when added in amount of 0.25% on a dry basis. In general, the higher the rate of water absorption by the sample, the poorer the texture.

LITERATURE CITED

1. Cooley, A. M., Severson, D. E., Peightal, D. E., and Wagner, J. R. Studies on dehydrated potato granules. *Food Technol.*, **8**, 263-269 (1954).

2. Neel, G. H., Smith, G. S., Cole, M. W., Olson, R. L., Harrington, W. O., and Mullins, W. R. Drying problems in the add-back process for production of potato granules." *Food Technol.*, **8**, 230-234 (1954).

3. Schoch, T. J. "The Fractionation of Starch," from *Advances in Carbohydrate Chemistry*. 1945, Vol. I, Ed. by Pigman, W. W., and Wolfram, M. L. Academic Press, New York.

Effect of Processing Conditions on the Viscosity of Tomato Juice[a]

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Under conditions comparable to commercial operations, the factors affecting the consistency of tomato juice were studied. It was demonstrated that a wide range of viscosities can be obtained by adjusting finishing conditions at a given preheating temperature. The finisher was shown to be an important unit in controlling viscosity. The effect of the preheater on gross viscosity is due to a softening of the chopped tomatoes prior to finishing in addition to the preservation of the pectin in the serum. Microscopic study indicated gross viscosity to be due primarily to the number and shape of suspended particles. A difference of 20% in gross viscosity is perceptible to a taste panel.

During the preliminary phase of a study on the relationship of raw product grades to the quality of canned tomato juice *(1)*, large variations were noted in the viscosity of juice prepared on a pilot plant scale. This prompted a study of the factors affecting tomato juice consistency under conditions comparable to commercial operations.

Kertesz and co-workers *(2, 3, 5)* have pointed out that the viscosity of whole tomato juice (gross viscosity) depends upon the viscosity of the serum (tomato juice freed of suspended particles) and upon the viscous character of the suspended particles. The role of pectin in determining viscosity and the importance of the preheating temperature for inactivation of the pectic enzymes were emphasized. As a result of these laboratory studies and limited tests under commercial conditions *(7)*, a relatively high preheating temperature was recommended for the manufacture of tomato juice.

The results presented in this paper show that a wide range of viscosities can be obtained by adjusting the finishing conditions at any given preheating temperature. Since the maximum obtainable gross viscosity is not generally desired in commercial tomato juice, it is not necessary to preserve the pectin in the serum.

It should be pointed out that these results do not necessarily apply to tomato products in which maximum viscosities might be desirable.

EXPERIMENTAL

The processing equipment used in this study simulated commercial production of tomato juice in a continuous manner at the rate of 1 gallon per minute *(6)*. Because the individual units of this processing line were small, it was possible to interchange them and to vary the manufacturing conditions over a wide range. In addition to the paddle type finisher[c] normally used in the grade relationship study, a tapered screw type extractor[d] was employed on occasions to remove the skins and seeds. A small piston type homogenizer[e] was used when studying the effects of homogenization on juice viscosity.

A further advantage gained through the use of small scale equipment lay in the small lots of raw material needed for each experimental condition which made it possible to complete a series of tests with one load of tomatoes. Variation in quality of raw material was further reduced by segregating each load into grades, No. 1, No. 2A (color deficient) and No. 2B (defects), and then weighing definite amounts of each grade to form experimental lots of 125 to 150 pounds each.

Viscosity measurements were made on the whole tomato juice samples (gross viscosity) and upon the tomato juice serum after removal of the suspended solids by filtration. Since tomato juice is a non-Newtonian liquid wherein stress is not proportional to rate of shear, all single gross viscosity measurements are actually "apparent viscosity" values as presented in this paper.

A wide range of manufacturing conditions in the pilot plant has produced juices with extreme variations in both serum and gross viscosity (Figure 1). The serum viscosities ranged approximately from 0.95 to 2.3 centipoises at 30° C., as measured in a 5-ml. Ostwald viscosity pipette. The apparent gross viscosities varied from 20 to 375 centipoises at 30° C., as measured with a Brookfield Model LVF viscosimeter using a No. 2 spindle at 60 r.p.m. Viscosity measurements in the Stormer viscosimeter, also at 30° C., were made using a 50-gram weight. In using the Brookfield viscosimeter, centipoise values are read directly. In the case of the Stormer, the centipoise values were obtained by preparing a curve with standard sugar solutions. At any given temperature the apparent viscosity of a truly viscous material never changes, but the apparent viscosity of all other types of material changes with variation of stirring speed. Since whole tomato juice is not a truly viscous material, the Broookfield viscosimeter, having a constant rate of revolution, is the preferable instrument.

The ranges in serum and gross viscosities encountered during the 1951 season are shown in Figure 1, with the range of the commercial samples emphasized by enclosure within the broken line.

In addition to theoretical considerations the Brookfield instrument was found to be preferable to the Stormer viscosimeter because of greater sensitivity in the region of viscosities found in commercial tomato juice and because of the speed and convenience in making the tests. The relation between measurements made by the two instruments is shown in Figure 2. In the region of extremely high viscosities, the range of the two instruments is in closer agreement, but in this region the Stormer is tedious to use because of difficulty in getting agreement between readings and because the observed viscosity of a given sample decreases with each repeated determination. Al-

[a] Approved by the Director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 946.

[b] Deceased, February 17, 1955.

[c] F. H. Langsenkamp Co., Indianapolis, Indiana Catalog No. 48, p. 27.

[d] Chisholm-Ryder Co., Niagara Falls, New York Catalog No. 51, p. 54.

[e] Cherry-Burrell Corp., Chicago, Illinois Size Jr. 75.

though single measurements of the viscosity of a non-Newtonian fluid are of limited theoretical significance, it was decided, for practical purposes, to make use of the Brookfield viscosimeter in order to obtain readings related to consistency. In interpreting the data, it must be borne in mind that apparent viscosities of non-Newtonian materials such as tomato juice are not absolute values, but vary widely with the method of measurement.

Sensory Perception of Consistency

Numerous tests with taste panels have demonstrated that the average observer is sensitive to gross viscosity in tomato juice and can distinguish differences amounting to about 20%. Using the triple test method with one of 3 samples differing in gross viscosity by 25%, the taste panel was able to make a significant number of correct selections of like and unlike samples. Figure 3 shows a typical series of taste tests demonstrating the effect of decreasing gross viscosities on the percent of correct selection.

The taste panel was not nearly so sensitive to differences in serum viscosity in triple tests when all 3 samples had the same gross viscosity. One comparison was made involving an increase of almost 100% in serum viscosity (far outside the range of any commercial samples encountered in this investigation) with less than the significant percentage of correct selections. The detailed results of the experiments with the taste panel are given in Table 1.

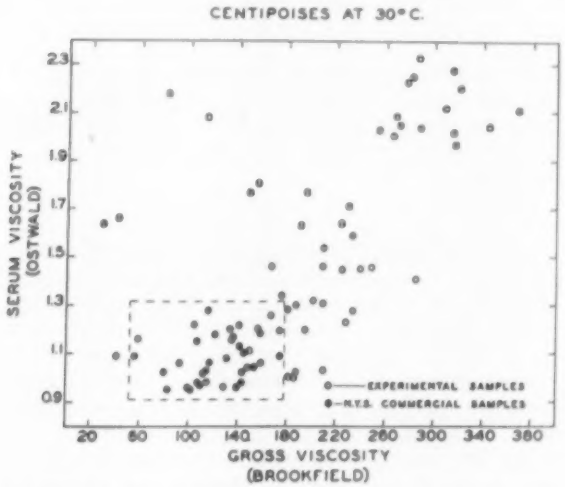

Figure 1. Range in serum and gross viscosities of tomato juice.

Great care needs to be taken in the interpretation of the taste panel results. A significant percentage of correct selection proves only that a detectable difference exists. The samples must be so selected that the difference is solely in viscosity and that the selection is not assisted by any other differences such as flavor, color, or coarseness of particles.

All of the samples used in the taste panel studies had been manufactured with the same finisher screen. Obviously differences in coarseness of particles will affect the sensation of smoothness which is an important element of mouth feel or consistency. Smoothness is imparted to juice by the use of a fine screen at the finisher or by homogenizing. These experiments demonstrate that in juices with uniform gross viscosity and particle size, large differences in serum viscosity do not impart any detectable differences in consistency.

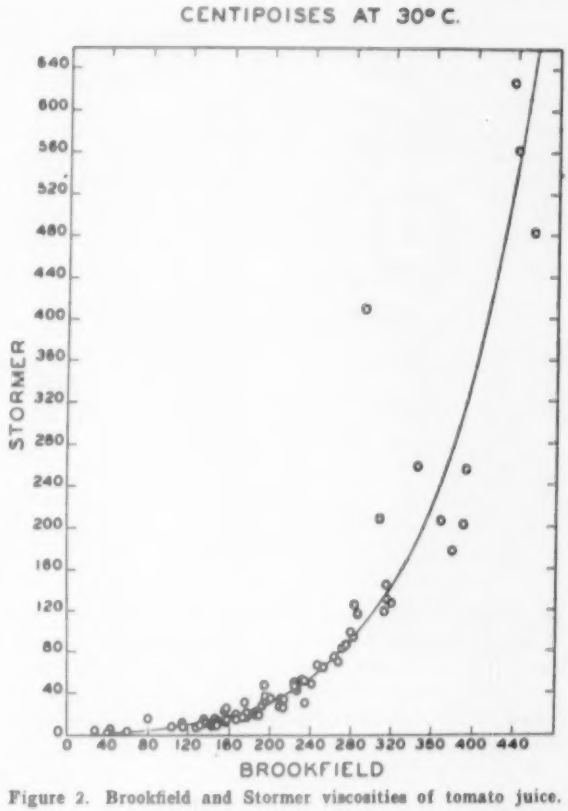

Figure 2. Brookfield and Stormer viscosities of tomato juice.

The Effect of Action of the Finisher on Gross Viscosity

In the range of conditions likely to be encountered in the manufacture of tomato juice, the preheating temperature primarily determines serum viscosity while the speed and type of finisher exerts its greatest effect on gross viscosity. The effects of processing conditions

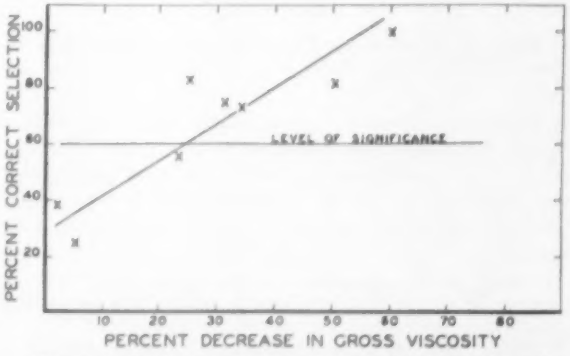

Figure 3. Taste panel tests on tomato juice viscosity. The relation of percent correct selection to decrease in gross viscosity.

TABLE 1
Taste panel tests on the viscosity of tomato juice

Viscosity in cp at 30° C.		% decrease in viscosity		Number of tasters	Percent correct selection	Percent correct selections needed		
Gross	Serum	Gross	Serum			Significant	Highly significant	Very highly significant
170 69	1.18 1.16	60	2	13	100	58	66	76
235 119	1.29 1.26	50	2	13	81	58	66	76
263 174	1.03 1.02	34	1	11	73	60	69	81
171 118	1.18 1.00	31	15	12	75	59	68	79
157 118	1.16 1.00	25	14	12	83	59	68	79
235 180	1.29 1.28	23	1	16	56	57	64	74
253 240	1.46 1.28	5	13	8	25	61	72	83
241 237	1.98 1.04	2	48	13	38	58	66	76
	1.98[1] 1.04[1]		48	10	30	61	79	83

[1] Serum of these juices separated by centrifuging.

on the serum and gross viscosities of tomato juice are shown in Figures 4 and 5 for two preheating temperatures and with and without preheating. Some effect on serum viscosity was produced by changes in finisher speed. However, this effect was small in comparison to the several-fold increase in gross viscosity.

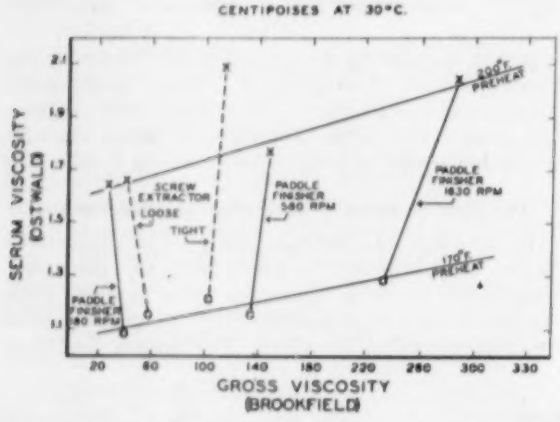

Figure 4. Effect of finisher on viscosity of tomato juice at two preheating temperatures.

Since gross viscosity was found to depend on finisher speed, the studies were extended to determine the effect of finisher speed over the entire range of preheating temperatures. Contrary to expectations it was found that juice that was relatively high in both serum and gross viscosity could be obtained at a finishing temperature of 70° F. without preheating. This fact is largely of theoretical significance since there are other reasons justifying the use of a preheater.

Figure 5 shows a comparison of the effects of finisher speed (paddle type) on both serum and gross viscosity of juice with and without preheating. It is apparent that the preheating temperature affects both serum and gross viscosity and that its effect on gross viscosity becomes more pronounced as the finisher speed is increased.

Depending upon the temperature reached and rate of heating, heat treatment prior to finishing may either stimulate or destroy pectic enzymes. In addition to its effect on serum pectin, the preheater exerts a softening effect on the tomato tissue which in turn has an important practical influence on the action of the finisher. In the usual continuous process of manufacture, preheating and finishing temperatures are approximately the same. In order to separate the effect of temperature at the preheating and finishing operations, tomato juice was cooled after preheating, and then heated a second time to the desired finishing temperature. Assuming that the first heat treatment inactivated the pectic

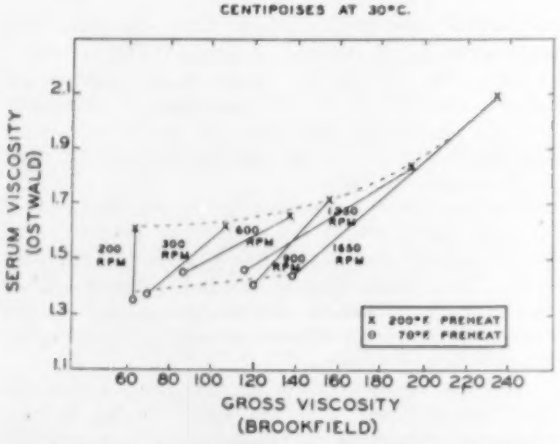

Figure 5. Effect of finisher paddle speed on viscosity of tomato juice with and without preheating.

enzymes, it can be concluded that the second heat treatment altered both serum and gross viscosities by further softening of the tomato tissue prior to finishing (Table 2). These results also show the direct interrelationship between serum and gross viscosities.

TABLE 2
The effect of finishing temperature on the viscosity of tomato juice

Preheating temperature	Finishing temperature	Viscosity of juice in cp at 30° C.	
		Gross (Brookfield)	Serum (Ostwald)
° F.	° F.		
170	100	186	1.00
170	140	181	1.00
170	170	187	1.02
170	200	210	1.03
200	100	230	1.71
200	140	315	2.02
200	170	316	1.96
200	200	344	2.04

Instead of using the terms "hot and cold break" it is sufficient to state whether the chopped tomatoes were preheated prior to finishing and to report the preheating temperature. The use of the term "hot-break" has caused a great deal of confusion because of the implication that the necessary heating must be accomplished during or immediately after chopping or crushing in order to preserve the pectin in the juice *(3)*. As a matter of fact, holding chopped tomatoes at room temperature for several hours before heating causes no significant reduction in either serum or gross viscosity. Table 3 shows the results of experiments in which chopped tomatoes were held at 70° F. and at 130° F. for times up to 4¾ hours after chopping and before preheating. There was no significant effect on the viscosity of the juice except when the juice was finished without preheating and held for one hour after finishing. The explanation for the apparent discrepancy between these findings and earlier reports of the rapid disappearance of pectin *(3)* may be due to the fact that in the earlier work the cellular tissue of the tomatoes was more completely disrupted than would have occurred if a chopper had been used.

TABLE 3
The effect of holding chopped tomatoes on the viscosity of tomato juice

Conditions of holding after chopping		Finishing temperature	Viscosity of juice in cp at 30° C.	
Temperature	Time hrs.		Gross (Brookfield)	Serum (Ostwald)
° F.		° F.		
70	0	170	205	1.23
130	0	170	208	1.29
130	1	170	248	1.53
130	2	170	252	1.40
130	4	170	235	1.38
130	0	200	221	1.33
130	4	200	241	1.44
70	1¼	170	235	1.20
70	4¼	170	225	1.60
Conditions of holding after finishing				
70	0	70	209	1.77
100	1	70	174	.98

Table 4 is a summary of experiments conducted during the 1952 season showing the wide range in gross viscosities that can be obtained by a variation in processing conditions. The results appeared to depend to some extent on the degree of ripeness or condition of the tomatoes but repeated trials with identical manufacturing conditions showed remarkably close agreement.

TABLE 4
Effect of processing conditions on gross viscosity of tomato juice [1]

Finisher speed r.p.m.	Finisher screen size inches	Preheating temperature		
		70° F. Gross viscosity cp	160° F. Gross viscosity cp	200° F. Gross viscosity cp
200	.023	46	14	27
200	.023	58	43	33
200	.033	77	59	53
200	.045	71	72	77
200	.060	92	80	97
400	.023	92	72	87
800	.023	120	138	127
800	.023	119	143	170
800	.033	150	160	211
800	.045	158	184	245
800	.060	192	178	259
1600	.023	138	117	176
1600	.023	141	168	206
1600	.033	157	197	246
1600	.045	155	201	257
1600	.060	183	224	272

[1] 1952—Red Jacket Tomatoes, No Vibratory Screen, Langsenkamp Paddle Finisher.

The observed increase in gross viscosity with increase in screen size is of no practical significance since the tomato juice made with all screen sizes above 0.023 showed defects due to the appearance of specks consisting chiefly of seed fragments.

The Effect of Preheating Temperature on Serum and Gross Viscosity

The effect of preheating temperature on serum and gross viscosities of tomato juice is shown in Figures 6

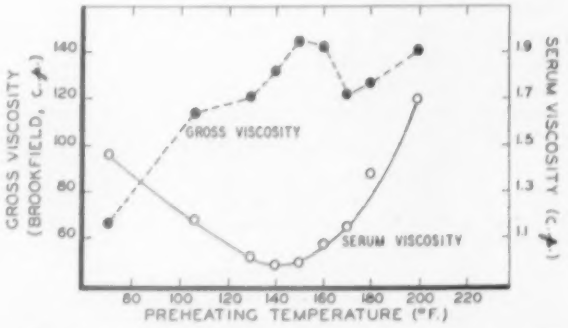

Figure 6. Effect of preheating on tomato juice viscosity with shaker screen and a paddle speed of 540 r.p.m.

and 7. With a slow finisher speed the gross viscosity was low at the low end of the preheating temperature scale. With the high finisher speed the gross viscosities were high at the higher preheating temperatures. At intermediate temperatures there was no constant trend.

The effect of preheating temperature on serum viscosity is much more clear-cut. The serum viscosity passes through a minimum at 140-150° F. On one side of this minimum the pectic enzymes are inactivated by the high temperature and on the other side of the minimum the enzymes are inhibited by the low temperature. The results in Figures 6 and 7 confirm the published fact that an elevation of preheating temperature will increase the gross viscosity of tomato juice *(3, 7)*. The production of tomato juice with high serum viscosity at low preheating temperatures has not previously been reported. It is interesting that the preheating temperatures (150-160° F.) most commonly employed commercially in New York are near the minimum for serum viscosity.

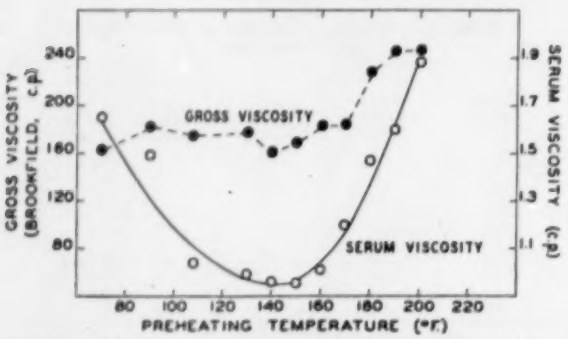

Figure 7. Effect of preheating on tomato juice viscosity without shaker screen and paddle speed 1600 r.p.m.

Manufacturing Conditions Other Than Finishing and Preheating

A number of studies have been undertaken to determine if other steps in the manufacturing process have a signicant influence on gross viscosity. The degree of chop was controlled by varying the slit width in the outlet below the chopper and was found to have little or no effect on the gross viscosity of the juice as shown in Table 5. This set of samples again illustrates the large effect of finisher speed on gross viscosity as well as a lesser effect on serum viscosity. Table 6 shows that the use of a vibratory screen in the pilot plant line *(6)* between the preheater and finisher has little or no effect on viscosity. Table 7 gives representative data demonstrating that the viscosity is independent of the pasteurization temperature.

TABLE 5
The effect of degree of chop on viscosity of tomato juice

Chopper slit width	Finisher speed r.p.m.	Viscosity in cp at 30° C.	
		Gross (Brookfield)	Serum (Ostwald)
¼"	1630	294	1.98
½"	1630	298	2.22
¼"	580	160	1.71
½"	580	161	1.78

TABLE 6
The effect of a vibratory screen on the viscosity of tomato juice

Use of vibratory screen	Finisher operation	Viscosity of juice in cp at 30° C.	
		Gross (Brookfield)	Serum (Ostwald)
Yes	1630 r.p.m.	221	1.12
No		252	1.21
Yes	580 r.p.m	196	1.10
No		193	1.12
Yes	screw	185	1.13
No	extractor	187	1.19

TABLE 7
The effect of pasteurizing temperature on the viscosity of tomato juice

Pasteurizing temperature	Viscosity of juice in cp at 30° C.	
	Gross (Brookfield)	Serum (Ostwald)
200° F.	203	1.12
250° F.	195	1.20
265° F.	204	1.22

MICROSCOPIC EXAMINATION OF TOMATO JUICE PARTICLES

Data in previous sections of this paper indicated that it might be profitable to investigate microscopically the nature of the suspended particles in tomato juice. Unlike many other juices, tomato juice is made by comminution of whole fruit, except for skins and seeds. Thus the juice consists of entire plant cells and their constituent parts and is not merely the liquid or cell sap pressed from tissues. Juice characteristics might be expected to depend partly on the structure of the original cells and cell walls.

A fresh ripe tomato is composed chiefly of large, thin-walled, nearly spherical cells (Figure 8) that contain living matter, various granules, and aqueous sap. In a tomato the cells are loosely stuck together with a pectic

Photomicrographs of tomato cells and juices. Magnification of all samples was 20 ×. For Figures 8, 9, and 11, ordinary (non-polarized) illumination was used; polarized light was used for Figures 10, 12, and 13. Juices used for Figures 9, 10, 12, and 13 were diluted one-fold with water and photographed as a layer 350 microns thick.

Figure 8. Unstained, living flesh cells from the center of a tomato.

Figure 9. Tomato juice as it appears at low magnification under ordinary illumination. Most of the dark specks are color granules. Some of the cell walls may be seen faintly.

Figure 10. Juice similar to that used for Figure 9 under polarized light and crossed Polaroids. Cell walls are visible but granules and other non-birefringent structures cannot be seen.

Figure 11. Broken cells and cell clusters separated from a juice during sieve analysis. The structures passed a 20-mesh sieve but were retained on one of 40-mesh size.

Figure 12. Tomato juice containing a minimum of suspended solids. Its gross viscosity was exceedingly low.

Figure 13. Tomato juice containing an appreciable quantity of suspended solids. Its gross viscosity was high.

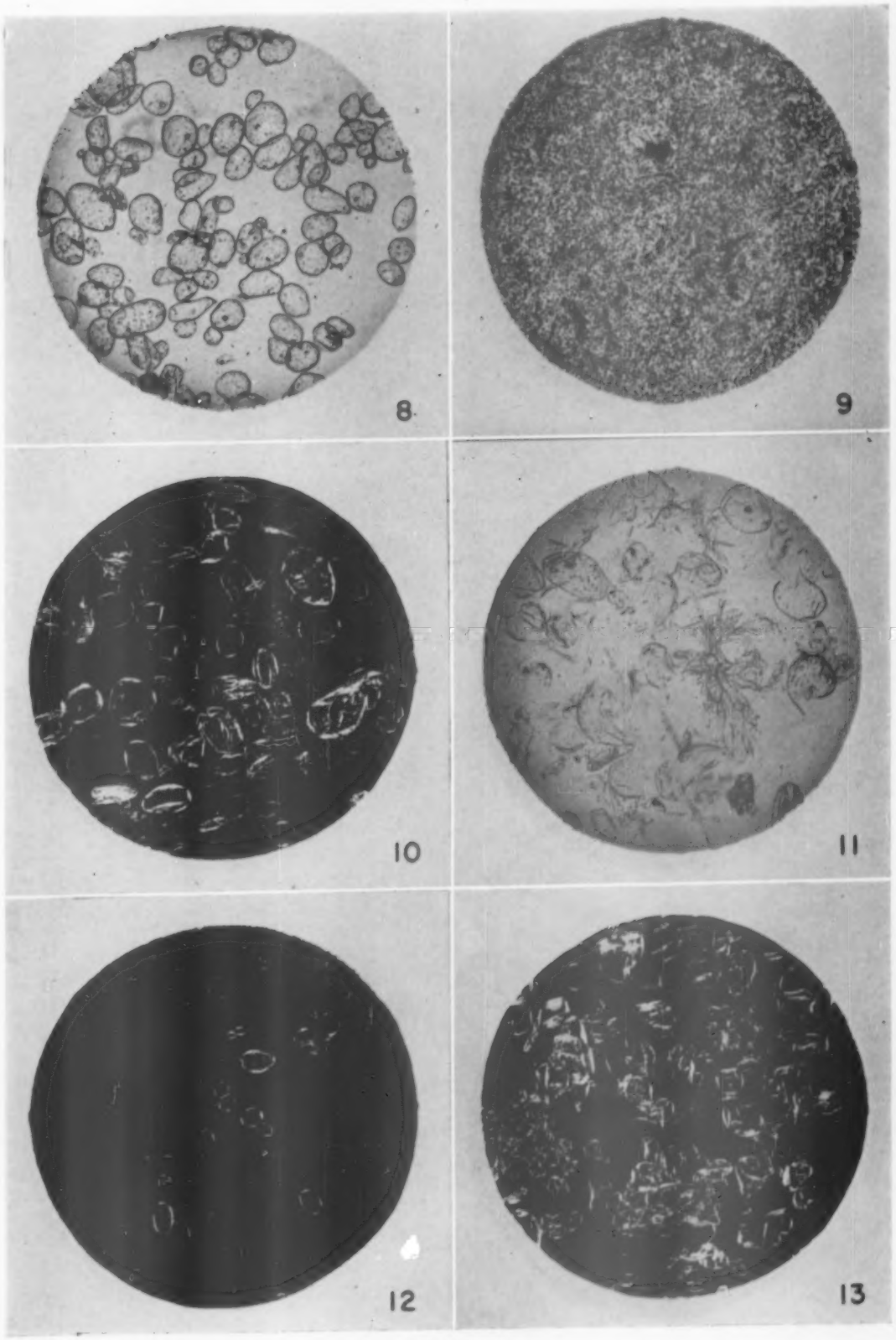

PLATE 1

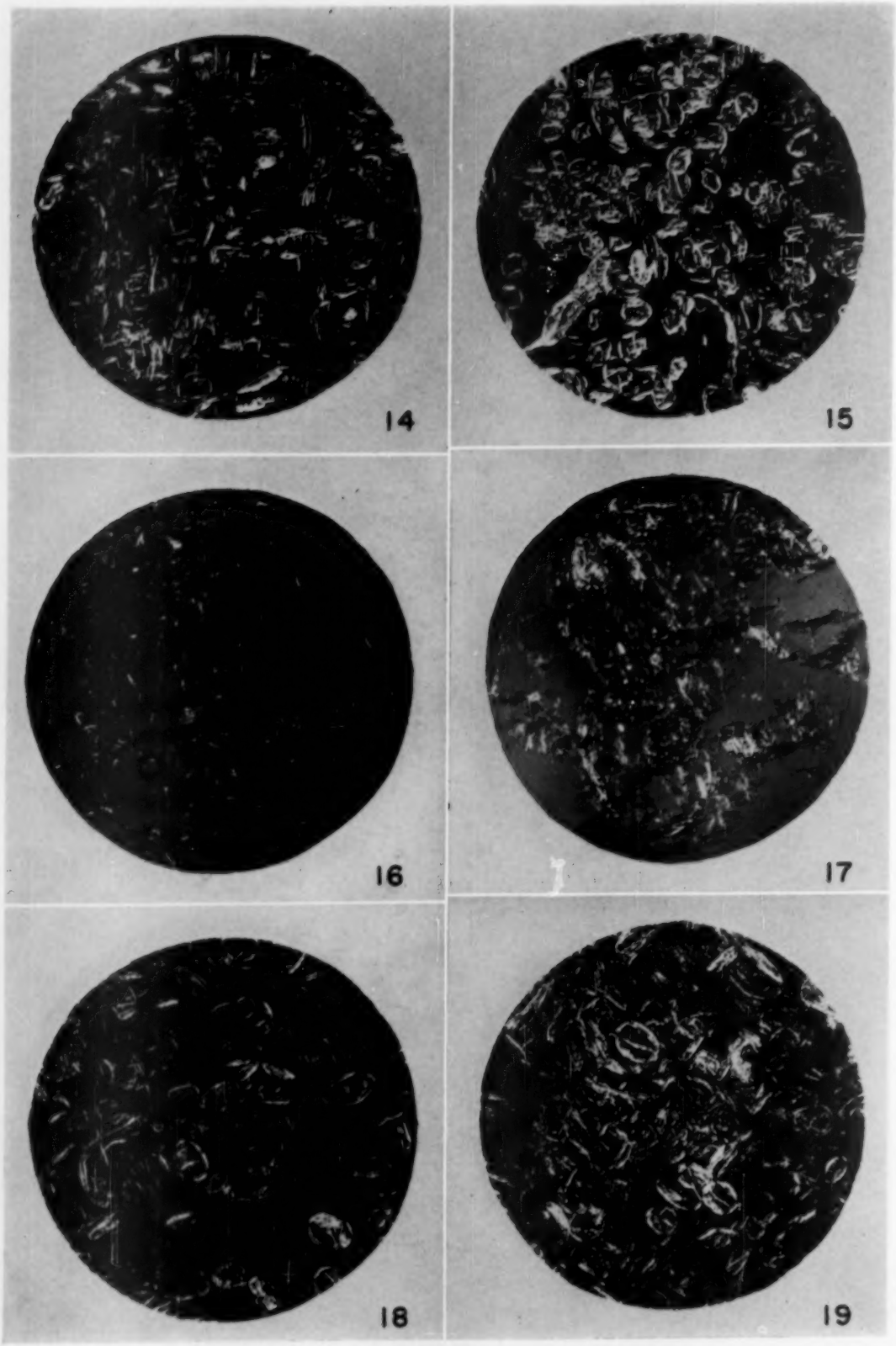

PLATE 2

cement. Although during juice manufacture the cells may become separated, distorted and broken, many of their structural parts are still recognizable in the finished juice. For instance, in Figure 9 the color granules liberated from broken cells are clearly visible, and in Figure 10, made with polarized light and crossed Polaroids, the cellulosic cell walls can be clearly seen. Cell walls may be seen faintly also in Figure 9, made under ordinary illumination. The structures shown in Figure 11 were obtained from a juice subjected to a sieve analysis as described by Kimball and Kertesz *(4)*. The relatively large cells, cell clusters, and cell wall fragments remaining on a 40-mesh sieve are seen.

If almost no suspended particles are present (Figure 12), the juice is extremely thin, its viscosity approximating that of water. If suspended matter is present in quantity (Figure 13), the gross viscosity of juice is high. However, quantity of cellular material alone may not govern gross viscosity; also important is the configuration or shape of the cell fragments. It is widely recognized that elongated particles have a greater effect on viscosity than do spherical particles. Thus fragmentation of the predominantly spherical cellular particles in a juice by partial homogenization (compare Figures 13 and 14) increases gross viscosity. The effect of more complete homogenization can be seen by comparing Figures 15 and 16. A higher magnification shows the brush-heap type of structure that contributes to the increase in viscosity caused by homogenization (see Figure 17).

The microscopic observations help to explain some of the results obtained by varying the conditions of finishing. For example, if the finisher is run at a low speed, a relatively small amount of suspended matter is incorporated in the juice, a high proportion of the particles remain spherical (Figure 18) and the juice is thin. At a high finisher speed, large quantities of suspended material are incorporated in the juice, the particles tend to be elongated (Figure 19), and the juice has a high gross viscosity. In most cases the significant differences in gross viscosity of juices can be explained in terms of differences in quantity, configuration, and character of the suspended particles. Work on the suspended cellular material in tomato juice is being continued.

Photomicrographs of tomato juice. Magnification used for Figure 17 was 50 ×; for all other samples the magnification was 20 ×. All juices were diluted one-fold with water and photographed as a layer 350 microns thick in polarized light.

Figure 14. Suspended solids in a partially homogenized juice. Gross viscosity was very high. Suspended solids in the original juice before homogenization are shown in Figure 13.

Figure 15. Suspended solids in an unhomogenized sample of juice. Gross viscosity was moderately low.

Figure 16. Small particles in a juice completely homogenized. Gross viscosity was very high. The suspended solids before homogenization are shown in Figure 15.

Figure 17. The suspended solids as in Figure 16 at higher magnification.

Figure 18. The suspended solids in a juice prepared at a low finisher speed. Gross viscosity was low.

Figure 19. The suspended solids in a juice prepared at a higher finisher speed. Gross viscosity was high.

SUMMARY

Representative samples of New York State commercial tomato juice had serum viscosities ranging from 0.9 to 1.3 centipoises at 30° C. when measured in the Ostwald viscosimeter. The gross viscosity of the same samples ranged from 60 to 180 centipoises at 30° C. when measured with the Brookfield viscosimeter.

A difference of 20% in gross viscosity in two samples of tomato juice is perceptible to a taste panel. In samples of uniform gross viscosity a 100% difference in serum viscosity had no perceptible effect on consistency as determined by a panel.

The finisher is an important unit for controlling the gross viscosity of tomato juice. With a paddle-type finisher, adjustment of the speed of the paddle will provide a wide range of gross viscosity regardless of the preheating temperatures.

The effect of the preheater on gross viscosity is due to the softening of the chopped tomatoes prior to finishing in addition to the preservation of the pectin in the serum.

Microscopic examination of tomato juices indicates that gross viscosity is due primarily to the number and shape of the suspended particles.

LITERATURE CITED

1. Hand, D. B., *et al.* The yield and quality of juice obtained from New York State tomatoes graded according to U. S. Dept. of Agriculture standards. New York State Agr. Exp. Station *Bull. 759*, 1953.
2. Kertesz, Z. I. Pectic enzymes. III. Heat inactivation of tomato pectin methoxylase (pectase). *Food Research*, **4**, 113-116 (1939).
3. Kertesz, Z. I., and Loconti, J. D. Factors determining the consistency of commercial canned tomato juice. *Tech. Bulletin No. 272*. March 1944. 36 pages. N. Y. State Agr. Exp. Station, Geneva, N. Y.
4. Kimball, L. B., and Kertesz, Z. I. Practical determination of size distribution of suspended particles in macerated tomato products. *Food Technol.*, **6**, 68-71 (1952).
5. McColloch, R. J., and Kertesz, Z. I. Recent developments of practical significance in the field of pectic enzymes. *Food Technol.*, **3**, 94-96 (1949).
6. Moyer, J. C., Holgate, K. C., LaBelle, R. L., and Hand, D. B. Tomato juice line. *Ind. Eng. Chem.*, **43**, 1874-1880 (1951).
7. Robinson, W. B., Stotz, E., and Kertesz, Z. I. The effect of manufacturing methods on the ascorbic acid content and consistency characteristics of tomato juice. *J. Nutrition*, **30**, 435 (1945).

Feasibility of Using Plastic Film Packages for Heat Processed Foods[a,b]

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The feasibility of using plastic film packages for heat processed food was studied. The first phase concerned the investigation of plastic films to determine which might offer the required properties. Three films were found which exhibited superior characteristics regarding heat stability. The moisture vapor, oxygen, and organic vapor transmission of two of these films were determined as related to the heat treatment. These two films were also used experimentally for heat processing of tomato juice, apple sauce, beef stew, and club steaks. Although the results obtained from this work demonstrated the possibility of using plastic film material for this purpose, many additional problems remain to be solved before practical use can be made of this work.

Under the concept upon which this study is predicated, the film packages for heat-processed foods must sustain a heat treatment after the packages are filled with food and sealed. Also, after heat sterilization, the film packaged foods should be commercially sterile and require no special holding conditions such as cold storage. It is recognized that in any attempt to use plastic materials for packaging heat processed foods on a commercial scale many complicated problems, such as economy, possible toxicity, permeability, sealing, filling, storage stability, and others, would be encountered. However, the plastic materials of high heat resistance might offer unique opportunities and advantages in the food packaging field. These are:

a. The empty plastic containers could be delivered as a continuous roll of pouches or tubes with their sides pressed to each other. In this compact form, a huge amount of shipping and storing space for empty containers would be saved.

b. The plastic container is generally transparent or translucent, which would contribute eye-appeal to bright-colored food products which are not light sensitive.

c. The plastic film can be shaped into irregular forms for special containers. It is particularly suitable for packaging flat food products such as steaks, chops, and fillets.

d. The plastic container is squeezable, which would aid in removing viscous food products.

e. The plastic film is readily adaptable to radiation or so-called "cold sterilization" *(8)*.

A primary criterion. Many commercial heat processes for foods are carried out at a temperature of 250° F. (121° C.). Therefore, it would appear that the first requisite of a plastic suitable for heat processed foods would be resistance to physical change which might be caused by exposure to steam temperatures of 250° F. (121° C.). In recent years some new plastic films have been developed with melting points which are reportedly higher than this value *(2, 7, 14)*. No data have been reported, it appears, on the use of such films for the fabrication of plastic packages for heat-processed foods.

MATERIALS AND METHODS

Preliminary screening tests. The first screening study was carried out to evaluate the general heat resistance properties of the films. In this test, one set of film samples was subjected to 30 minutes treatment in boiling water, while another set of film samples was subjected to 30 minutes treatment in 250° F. (121° C.) steam at 15 lbs. pressure. The films which appeared to withstand these 2 temperatures were subjected to the second screening test. This test was of an organoleptic nature and determined whether a bad taste or a sediment might be imparted to food by the film. In preparation for this screening test the films, cut into one-inch squares, were immersed in boiling distilled water under reflux for 30 minutes. A layer of glass beads was placed on the bottom of the flask in order to prevent direct contact of the film sample with the heated flask. The resulting solution was organoleptically evaluated and its turbidity measured with the Lumetron photoelectric colorimeter.

Permeability determinations. The water method of the American Society for Testing Material *(4)* was used to measure the water vapor permeability. About 20 ml. of distilled water at 115° F. (46° C.) was added to a test dish with a sample area of 20.6 sq. in. The test conditions were 100° F. (38° C.), 30% relative humidity, and a time interval of 72 hours. For comparison, packages of processed apple sauce made with the same films were also placed in the test cabinet and their weight loss measured.

The permeability of the films to oxygen and carbon dioxide was determined by the method of Landrock and Proctor *(9)*. Conditions were controlled at 85° F. (29.4° C.) and 0% relative humidity. Polythene 200 was used as a control material for checking the apparatus periodically.

The organic vapor permeability of the films was determined according to the methyl furoate method developed by Muldoon, Couch, and Barnes *(10)*. The temperature was 73° F. (22.8° C.), the relative humidity was 84%, and Cellophane PT-450 was the control film.

Permeability determinations were made in triplicate on the films as received and after each heat exposure.

Packaging of acid and non-acid foods. Apple sauce and tomato juice were packaged as examples of acid foods; in the non-acid food class potato-meat stew was chosen. The plastic films considered suitable for food packaging and processing studies were available only in sheet form.

In preparing the plastic bags for food packaging, the film sheet was folded and sealed at 2 sides to form a bag. After the

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bag had been filled with food products, the open end was sealed immediately. Care was taken to eliminate as much air as possible from inclusion in the package. A manually operated thermal impulse heat sealer, manufactured by Vertrod Corporation, Brooklyn, N. Y., was used throughout this study for the sealing of Mylar Polyester and Trithene films. This sealer had to be adjusted for the different types and thicknesses of film. Thus, difficulties were encountered in precisely duplicating each sealing operation as to pressure applied and duration and temperature of treatment. It is believed that distortion of the film sometimes occurred near the heat-sealed area. These considerations probably were responsible for the several instances where spoilage was found. This problem could probably be circumvented by a continuous controlled operation.

The processed apple sauce contained one-seventh by weight of sugar. This product and raw tomato juice were heated to 160° F. before packaging in plastic bags. The packages containing about 150 g. were sealed, heat processed in boiling water for 30 minutes, and then cooled in tap water.

The recipe for the potato-meat stew was as follows: Diced potatoes—1000 g., ground beef—1000 g., water—1500 cc., and sodium chloride—15 g. This mixture was raised to boiling temperature and then allowed to cool to 160° F. (71° C.) before packaging. The plastic film packages of this non-acid food were heat processed in a water and air super-imposing retort at 250° F. (121° C.) for 25 minutes. This thermal process was considered more than adequate because heat penetration tests of the meat-stew showed that about 10 minutes was required to raise the center temperature of the product to 248° F. (120° C.).

Organoleptic analysis. The organoleptic testing throughout the entire study was conducted on a blindfold basis and was based on a scoring system which ranged from one to nine with one indicating the least acceptable rating. Scores under five showed the material to be definitely unacceptable. The taste panel consisted of 4 members. The results are shown as the closest whole number to the average value. The untreated films were first smelled and then chewed for one-half minute before being rated. After the films had been boiled for 30 minutes as described above, the water was decanted and cooled to room temperature. This water was then tasted by the panel and its turbidity measured.

Color measurement. The color of the tomato juice was objectively measured with the Hunter color difference meter—a photoelectric tristimulus instrument. Eighty cc. of tomato juice was taken for each measurement and reference plate No. 25 was used as the reference for standardizing the instrument.

RESULTS AND DISCUSSION

Screening tests. With the rapid expansion of the use of plastic films for food packaging, many authors *(3, 5, 11, 12)* have described the general mechanical, physical, and chemical properties of various films suitable for fresh, dried, or frozen food packaging. These films include a number of plastics that reportedly soften, wrinkle or break at temperatures of 200-250° F. The literature covering films of high heat resistance discloses at least seven films with melting points or resistance to heat above 250° F. These are Saran, Cellophane, trithene, Teflon, Polyvinyl chloride film for blood pack, Tygon S22-2, and Mylar Polyester. Also included were two films of lesser heat resistance, namely Pliofilm and Polyethene.

Those films with melting points above 250° F. but whose general physical characteristics are impaired by exposure to high temperatures or which exhibit unacceptable tastes or odors may be eliminated from further study.

Test for heat resistance. The results of the screening test for heat resistance are given in Table 1. Pliofilm, Polythene, and Cellophane were either broken apart or had their surface peeled off in layers when subjected at 250° F. for 30 minutes. Therefore, these films were eliminated from further study.

Organoleptic evaluation of the films. The remaining 6 films not eliminated in the first screening test were evaluated for odor, taste, and breakdown upon being heated. The results of these tests are tabulated in Table 2. The odor of Tygon and Vinyl blood pack was found unacceptable. The taste of the water from the boiled Tygon S22-2, Vinyl blood pack, and Saran A517 was completely unacceptable. Also, the water from these 3 samples was definitely cloudy. This turbidity did not become apparent until the solutions were cooled. The results led to the conclusion that these 3 films might impart an undesirable taste and turbidity to food processed in them and they were therefore eliminated from further consideration.

Heat sealability. No satisfactory method was available for heat sealing Teflon which was received only in the sheet form. This situation made it practically impossible to package food in Teflon for heat processing studies. Therefore, Teflon was not studied further while Mylar Polyester A and Trithene A were evaluated in more detail.

Permeability studies. In considering the use of plastic films for packaging heat processed foods, the characteristics of the film permeabilities are extremely important. Therefore, the films which passed the screening tests were evaluated for their permeability to water vapor, oxygen, carbon dioxide, and organic vapor. These determinations were made both before and after heat treatment.

Water vapor. Pliofilm N1 140 was used as a control material in each determination. Six different thicknesses of Mylar Polyester A film were investigated from their water vapor permeability. The results are presented in Table 3. They show a hyperbolic relationship, $xy = K$, between the film thickness and its permeability. In other words, the water vapor transmission rate of Mylar Polyester A is inversely proportional to the film thickness. This is in accordance with theory for water vapor permeability of hydrophobic polymers as stated by some workers *(1, 6)*.

To study the effect of heat exposure on the water vapor transmission rate of the film, Mylar Polyester A and Trithene A were exposed to steam at 212° F., 230° F., and 250° F. for 30 minute intervals each. The results, given in Table 4, show that Mylar Polyester A has a relatively moderate water vapor transmission rate which has a slight tendency to increase as the film is exposed to a higher temperature. Trithene A film has a very low water vapor transmission rate which is about 3% that of Mylar Polyester A and about one-fourth that for Saran A517.

Water vapor transmission rates shown by the dish method were compared to weight loss of apple sauce packaged in the same film. The dish mounted film had also been heat treated for 30 minutes in boiling water. The determinations were made on two thicknesses of each film, in triplicate, for the packaged food

These results lead to two conclusions. First, the weight loss of apple sauce in the plastic bag is largely governed by the water vapor permeability of the film. Secondly, the rate of weight

TABLE 1

The test for heat resistance (the first screening test)

Samples	Hot water treatment, 210-212° F., 30 min.	Live steam treatment, 250° F., 30 min.
1. Pliofilm HP, 140	Slightly more opaque than original sample	Film broken apart
2. Polythene 200	Slightly more opaque than original sample	Film broken apart
3. Cellophane MSAT, 450	Slightly wrinkled, easy to break	Surface layer peeled off
4. Tygon S22-2	Slightly more opaque than the original	More opaque, pieces adhered to each other
5. Vinyl blood pack	Slightly more opaque than the original	More opaque, pieces adhered to each other
6. Saran A 517,200	Shrunken and opaque	Shrunken and pieces adhered slightly to each other
7. Mylar Polyester A, 200	No visible change	No visible change
8. Trithene A, 200	No visible change	No visible change
9. Teflon, 500	No visible change	No visible change

loss by packaged apple sauce is slightly more than that shown by the water in the dish method. This may be due to the hydraulic pressure exerted by the liquid apple sauce upon the plastic bag as compared to the water vapor in contact with the film in case of the dish method. Also, the film of the packaged food may be distended or distorted to a certain degree due to the food encased in the bag. This might decrease the film thickness and thereby increase its permeability.

TABLE 2
Organoleptic evaluation of six films, untreated and after exposure to heat

Film sample	Untreated films		Boiled water decanted from films and cooled to room temperature		
	Odor	Taste	Taste	Relative transparency [1]	Degree of turbidity [2]
				%	
1. Tygon, S22-2	3	3	2	89	Very cloudy
2. Vinyl blood pack	3	8	1	93	Moderately cloud
3. Saran A517, 200	8	9	1	86	Very cloudy
4. Mylar Polyester A, 200	9	9	8	99	Clear
5. Trithene A, 200	9	9	8	100	Clear
6. Teflon, 500	9	9	7	99	Clear
7. Distilled water			8	100	Clear

[1] Measured by Lumetron photoelectric colorimeter with a 420 mμ filter.
[2] Judged by naked eye.

Gas. The results for oxygen and carbon dioxide permeability presented in Table 6 show a close agreement between the data obtained for Polythene and those presented by Landrock and Proctor for Polyethylene. The gas permeability of Mylar Polyester A and Trithene A was determined before heating and after exposure to steam at 212° F., 230° F. and 250° F. for 30 minutes. The oxygen and carbon dioxide permeabilities of both Mylar Polyester A and Trithene A were very low. Since the exposure to moist heat did not alter the gas permeability of the film appreciably, the results are not separately shown in Table 6. Also, due to the limitation of the accuracy in the gas analysis determination in this low range, the significance of the data is limited. The oxygen permeability for both films after heat treatment apparently did not exceed 50 cc./100 sq. in./24 hrs./atm., while the carbon dioxide permeability of both films did not exceed 65 cc./100 sq. in./24 hrs./atm.

TABLE 3
Relationship of film thickness of Mylar Polyester A to its water vapor transmission rate

Film thickness gauge (x)	Water vapor transmission rate g./100 sq. in./24 hrs., (y)	K
50	2.225	111
100 = 1 mil.	1.266	127
200	0.634	127
300	0.411	123
500	0.280	140
700	0.197	138

and for the dish method. The average values of the results for this study are shown in Table 5.

Organic vapor. From a preliminary study, the Mylar Polyester A and Trithene A films showed very low transmission rates of methyl furoate vapor. A 14 days' storage period was used for the above 2 films and more than 6 days' storage period for Cellophane PT-450. Results of the organic vapor determination are given in Table 7. They show that both Mylar Polyester A, 200 and Trithene A, 200 films are at least 5,000 times less permeable than Cellophane PT-450 to the methyl furoate vapor. It may also be seen that exposure of these films to high temperatures may have a slight tendency to increase the organic vapor permeability of both films. However, resistance of these heated films to the vapor permeation is still relatively very high.

Packaging of acid foods in plastic bags. No spoilage was observed in apple sauce packaged in either film, although a total of 35 packages was prepared. However, apple sauce packaged in both films displayed a brownish gray discoloration which appeared during storage. This discoloration usually became apparent after 5 to 7 days in storage at a temperature of about 78° F. (25° C.). The intensity of this discoloration increased with time and was accompanied by off-flavor development.

TABLE 4
Determination of water vapor permeability before and after various heat treatments (cabinet atmosphere: 100° F. (38° C.) 30% R.H.)

Film samples	Exposed to heat	Water vapor transmission rate g./100 sq. in./24 hours x 10^{-2}
Pliofilm N1 140 [1]	None	52 to 62
Mylar Polyester A, 200	None	63.8
Mylar Polyester A, 200	212° F., 30 min.	65.4
Mylar Polyester A, 200	230° F., 30 min.	66.3
Mylar Polyester A, 200	250° F., 30 min.	72.7
Mylar Polyester A, 300	None	47.2
Mylar Polyester A, 300	212° F., 30 min.	55.1
Mylar Polyester A, 300	230° F., 30 min.	57.4
Mylar Polyester A, 300	250° F., 30 min.	53.8
Trithene A, 200	None	1.78
Trithene A, 200	212° F., 30 min.	1.99
Trithene A, 200	230° F., 30 min.	1.73
Trithene A, 200	250° F., 30 min.	1.89
Saran A 517, 200	None	8.0

[1] The sample was kindly given by Mr. P. K. Wolper of Riegal Paper Corporation, Milford, N. J. The WVTR determined by him was 0.60 to 0.67 g./100 sq. in./24 hrs. at 100° F. (38° C.) and 92% R.H.

TABLE 5
Water vapor permeability of film package containing processed apple sauce as compared to the dish method during a 10-week storage period

Film sample	Water vapor permeability g./100 sq. in./24 hrs.	
	Packaged apple sauce	Dish method
Mylar Polyester A, 200 [1]	6.74×10^{-1}	5.88×10^{-1}
Mylar Polyester A, 300 [1]	4.85×10^{-1}	4.51×10^{-1}
Trithene A, 200 [2]	13.1×10^{-2}	8.26×10^{-2}
Trithene A, 400 [2]	2.52×10^{-2}	0.90×10^{-2}

[1] Obtained from E. I. Du Pont de Nemours & Co., Inc., Wilmington, Del.
[2] Obtained from Visking Corp., Chicago, Illinois.

TABLE 6
Gas permeability determination

Film sample	cc./100 sq. in./24 hrs./atm.	
	O_2	CO_2
Polyethylene, 150 [1]	470	1500
Polyethylene, 240 [1]	370	1000
Polythene, 200	386	1337
Mylar Polyester A, 200 (with and without heat exposure)	<50	<65
Trithene A, 200 (with and without heat exposure)	<40	<50

[1] Data are from Landrock and Proctor (9).

Since this phenomenon was of prime importance to the fundamental concepts of the study, an experiment was designed to investigate the discoloration and off-flavor development. The treatments were as follows:

Treatment No. 1

Apple sauce prepared, packaged in Mylar Polyester A and Trithene A bags and heat processed. This served as control.

Treatment No. 2

Apple sauce prepared, packaged in Mylar Polyester A and Trithene A bags placed in plain tin can and the space between the film packaged apple sauce and the can was filled with apple sauce. The can was sealed and heat processed.

Treatment No. 3

Three hundred mg. ascorbic acid was added per pound of apple sauce just before the sauce was filled into the plastic bags. Therefore, the No. 3 samples differed from the No. 1 samples only in the added ascorbic acid content.

After 26 days' storage at room temperature, the apple sauce from treatments Nos. 1, 2 and 3 were taste tested, and the concentration of ascorbic acid in the samples was determined. As shown by the results in Table 8, the organoleptic panel found that the No. 1 samples were definitely inferior to the No. 2 and No. 3 products with respect to color and flavor. Scores for the No. 3 samples indicated superiority over the No. 2 samples but it is questionable whether any significant difference existed between these two groups. No significant difference was apparent between the similar samples packed in Mylar Polyester A and Trithene A films. No. 3 samples, after 26 days of storage, contained about one-third of the originally added ascorbic acid. There was practically no ascorbic acid present in No. 1 and No. 2 samples after the similar storage period.

TABLE 7

Organic vapor permeability determination

Film sample	Exposed to heat	g. Furoic acid/ 100 sq. in./24 hrs.
Cellophane PT-450 [1]	None	5.43×10^{-3}
Cellophane PT-450	None	6.10×10^{-3}
Mylar Polyester A, 200	None	0.73×10^{-4}
Mylar Polyester A, 200	212° F., 30 min.	1.07×10^{-4}
Mylar Polyester A, 200	230° F., 30 min.	1.15×10^{-4}
Mylar Polyester A, 200	250° F., 30 min.	1.05×10^{-4}
Trithene A, 200	None	1.07×10^{-4}
Trithene A, 200	212° F., 30 min.	1.71×10^{-4}
Trithene A, 200	230° F., 30 min.	2.07×10^{-4}
Trithene A, 200	250° F., 30 min.	1.76×10^{-4}

[1] Data are from Muldoon, Couch, and Barnes *(10)*.

The cause of discoloration and off-flavor development in film packed apple sauce might be due to such factors as the chemical composition of the film, light, or oxygen. The possibility of the chemical composition of the film causing this phenomenon was eliminated, since No. 2 and No. 3 samples did not develop the off-color and off-flavor found in No. 1 samples. The effect of light was likewise negated in this experiment because No. 1 and No. 3 samples were laid side by side in a box. The only reasonable cause appeared to be oxygen, since the presence of ascorbic acid, an anti-oxidant, in No. 3 samples, and the absence of oxygen from the area surrounding the plastic bag in No. 2 samples did prevent the apple sauce from developing off-color and off-flavor. Apparently, the oxygen which produced the ill effect diffused into the bag largely during the storage period. The amount of oxygen which might have remained in the bag after sealing was insufficient to produce the undesirable effect. This point was illustrated by the results for No. 2 samples which contained no ascorbic acid. These samples were not exposed to air during storage and thus showed no off-color and flavor development.

Tomato juice was packed in 10 Mylar Polyester A and ten Trithene A film packages. Spoilage developed in four of the packages during a 45 days' storage period at room temperature. Faulty sealing or breaking of the sealed area during heat processing are probable causes. The experimental treatments were as follows:

Treatment No. 1

Plastic containers were filled at about 160° F., sealed and heat processed.

Treatment No. 2

Same as treatment No. 1, but the film packaged tomato juice was placed into a tin can. The space around the film packaged tomato juice was filled with tomato juice and the can was sealed and heat processed.

Average color and flavor scores of the tomato juice samples together with the corresponding readings on the Hunter color difference meter are reported in Table 9. It was apparent, both in the subjective and objective testing, that the film packaged tomato juice enclosed in a tin can with tomato juice on the outside area of the film package showed much brighter red color than the film packaged samples exposed to the air. Another observation of interest was that, after 45 days' storage, the tomato juice packed in Trithene A retained a relatively brighter red color than the tomato juice packed in Mylar Polyester A, even though both packages were exposed to the atmosphere. The Trithene A used in this experiment was one mil thicker than Mylar Polyester A. If we assume that oxygen diffusion through the bag during the storage period is the cause of the discoloration, then it is probable that oxygen diffusion has been extensive enough to cause the off-color development of tomato juice in Mylar Polyester A but not enough to cause a similar phenomenon in Trithene A during the 45 day storage period.

TABLE 8

Organoleptic evaluation and ascorbic acid content [1] of apple sauce in plastic bags after a 26-day storage at room temperature

Treatment no.	Films used for containers	Color	Flavor	Ascorbic acid, mg./100 g. sample
1	Mylar Polyester, A, 300	3	4	0.08
	Trithene A, 400	4	4	0.04
2	Mylar Polyester, A, 300	7	8	0
	Trithene A, 400	7	7	0
3	Mylar Polyester, A, 300	8	8	27.3
	Trithene A, 400	8	9	28.6

[1] Analyzed by the 2, 4 dinitrophenylhydrazine method *(13)*.

Packaging of non-acid foods in plastic bags. Thirty plastic bags, 15 containers made from Mylar Polyester A 300, and 15 from Trithene A 400, were used with potato-meat stew. Two of the Mylar Polyester A and 6 of Trithene A showed leakage and spoilage during the 50-day storage period at room temperature. The experiment covering the investigation on non-acid food was as follows:

Treatment No. 1

Potato-meat stew prepared, packaged in film and heat processed for 25 minutes in a special retort at a temperature of 250° F.

TABLE 9

Organoleptic evaluation and color measurement of tomato juice in plastic bags after a 45-day storage at room temperature

Treatment no.	Films used for containers	Color	Flavor	Reading in Hunter color difference meter			
				Rd	a	B	a/b
1	Mylar Polyester, A, 300	4	5	6.6	+21.4	+16.0	+1.34
	Trithene A, 400	7	8	7.1	+23.7	+16.6	+1.43
2	Mylar Polyester, A, 300	8	7	7.4	+24.8	+16.5	+1.50
	Trithene A, 400	8	9	7.4	+25.0	+16.5	+1.52

Treatment No. 2

The same as No. 1, but the film packaged potato-meat stew was placed in a tin can. The space around the package in the can was filled with potato-meat stew and the can was sealed and heat processed.

The packaged and processed potato-meat stew which was exposed to air during the 50-day storage period did not show much difference in color and flavor when compared with the film packaged product enclosed in the tin can (Table 10). In general, the potato-meat stew products were quite acceptable, both initially and after 50 days' storage.

TABLE 10

Organoleptic evaluation of potato-meat stew packaged in plastic bags after a 50-day storage period at room temperature

Treatment no.	Films used for containers	Color	Flavor
1	Mylar Polyester, A, 300	7	6
	Trithene A, 400	7	7
2	Mylar Polyester, A, 300	8	7
	Trithene A, 400	7	8

SUMMARY

The results of the preliminary screening tests may be summarized as follows:

1. Eliminated in test for heat resistance: Pliofilm, Polythene, and Cellophane. Observations: physical deterioration when heated in live steam at 250° F. for 30 minutes.

2. Eliminated in organoleptic evaluation: Tygon, Vinyl blood pack, and Saran. Observations: imparted an undesirable flavor and a turbidity to boiling water.

3. Eliminated because no satisfactory method available for heat sealing: Teflon. This film could be obtained only in sheet form.

4. Suitable for further study: Mylar Polyester A and Trithene A films.

Heat processed apple sauce in both of the last mentioned films developed a brownish gray appearance after 5 to 7 days' storage at room temperature. The addition of ascorbic acid to the apple sauce prevented the development of off-color and off-flavor during a 26-day storage period.

Tomato juice packaged in Trithene A 400 showed a better flavor and brighter red color than that in Mylar Polyester A 300 after 45 days' storage. The greater thickness of the former may have been beneficial. The film packaged potato-meat stew was quite acceptable, both initially and after 50 days' storage, in both cases.

The use of plastic materials for heat processed foods subjects the films to extremely severe physical conditions. It should be noted that none of the films studied were specifically developed for such use. New or improved films which can be readily sealed in a dependable and hermetic manner, have greater strength and elasticity, and have extremely low oxygen and moisture vapor transmission rates may allow practical application of plastic containers for heat processed foods.

LITERATURE CITED

1. Aiken, W. H., Doty, P. M., and Mark, H. Water vapor permeability. *Modern Packaging,* **18** (12), 137-140; 166-168 (1945).
2. Amborski, L. E., and Flieri, D. W. Physical properties of polyethylene terephetalate films. *Ind. Eng. Chem.,* **45** (10), 2290-2295 (1953).
3. American Management Association. New uses for plastics in packaging. *Packaging Series No. 35* (1950).
4. American Society for Testing Materials. Tentative methods of test for water vapor permeability of plastic sheets. *A.S.T.M. Standards on Plastics,* D697-42T.
5. Buck, J. A. Plastics in food packaging. *Canning Industry,* December, 1950.
6. Doty, P. M., Aiken, W. H., and Mark, H. Water vapor permeability of organic films. *Ind. Eng. Chem., Anal. Ed.,* **16**, 686-690 (1944).
7. Du Pont de Nemours & Co. Du Pont Mylar Polyester Film. *Technical Bulletin 1-2-53,* Du Pont de Nemours & Co., Film Department, Wilmington, Delaware.
8. Kempe, L. L., Graikowski, J. T., and Brownell, L. E. Ray-sterilizing food wrapping. *Food Engineering,* **25** (11), 55-56, 174 (1953).
9. Landrock, A. H., and Proctor, B. E. Gas permeability of films. *Modern Packaging,* **25** (10), 131-135, 199-201 (1952).
10. Muldoon, T. J., Couch, R. de S., and Barnes, M. M. Organic vapor transmission test. *Modern Packaging,* **24** (5), 123-126 (1951).
11. Packaging Catalog Corporation. *Modern Packaging Encyclopedia, 1953.* Packaging Catalog Corporation, New York, N. Y.
12. Penn, W. S. Properties of plastic films. *British Packer,* Part I. Moisture Permeability, June, 1949, p. 31; Part II. Moisture Absorption, July, 1949, p. 26; Part III. Resistance to Heat, October, 1949, pp. 38, 50.
13. The Association of Vitamin Chemists, Inc. *Methods of Vitamin Assay,* 1947. Interscience Publishers, Inc., New York, N. Y.
14. The Visking Corporation. Properties and Uses of the New Chemically Resistant Thermoplastic Film — Trithene. The Visking Corporation, Terra Haute, Indiana.

TECHNICAL PROGRAM AND ABSTRACTS

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Institute of Food Technologists

★

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Treatment No. 2

The same as No. 1, but the film packaged potato-meat stew was placed in a tin can. The space around the package in the can was filled with potato-meat stew and the can was sealed and heat processed.

The packaged and processed potato-meat stew which was exposed to air during the 50-day storage period did not show much difference in color and flavor when compared with the film packaged product enclosed in the tin can (Table 10). In general, the potato-meat stew products were quite acceptable, both initially and after 50 days' storage.

TABLE 10

Organoleptic evaluation of potato-meat stew packaged in plastic bags after a 50-day storage period at room temperature

Treatment no.	Films used for containers	Color	Flavor
1	Mylar Polyester, A, 300	7	6
	Trithene A, 400	7	7
2	Mylar Polyester, A, 300	8	7
	Trithene A, 400	7	8

SUMMARY

The results of the preliminary screening tests may be summarized as follows:

1. Eliminated in test for heat resistance: Pliofilm, Polythene, and Cellophane. Observations: physical deterioration when heated in live steam at 250° F. for 30 minutes.

2. Eliminated in organoleptic evaluation: Tygon, Vinyl blood pack, and Saran. Observations: imparted an undesirable flavor and a turbidity to boiling water.

3. Eliminated because no satisfactory method available for heat sealing: Teflon. This film could be obtained only in sheet form.

4. Suitable for further study: Mylar Polyester A and Trithene A films.

Heat processed apple sauce in both of the last mentioned films developed a brownish gray appearance after 5 to 7 days' storage at room temperature. The addition of ascorbic acid to the apple sauce prevented the development of off-color and off-flavor during a 26-day storage period.

Tomato juice packaged in Trithene A 400 showed a better flavor and brighter red color than that in Mylar Polyester A 300 after 45 days' storage. The greater thickness of the former may have been beneficial. The film packaged potato-meat stew was quite acceptable, both initially and after 50 days' storage, in both cases.

The use of plastic materials for heat processed foods subjects the films to extremely severe physical conditions. It should be noted that none of the films studied were specifically developed for such use. New or improved films which can be readily sealed in a dependable and hermetic manner, have greater strength and elasticity, and have extremely low oxygen and moisture vapor transmission rates may allow practical application of plastic containers for heat processed foods.

LITERATURE CITED

1. Aiken, W. H., Doty, P. M., and Mark, H. Water vapor permeability. *Modern Packaging*, **18** (12), 137-140; 166-168 (1945).

2. Amborski, L. E., and Flierl, D. W. Physical properties of polyethylene terephetalate films. *Ind. Eng. Chem.*, **45** (10), 2290-2295 (1953).

3. American Management Association. New uses for plastics in packaging. *Packaging Series No. 35* (1950).

4. American Society for Testing Materials. Tentative methods of test for water vapor permeability of plastic sheets. *A.S.T.M. Standards on Plastics*, D697-42T.

5. Buck, J. A. Plastics in food packaging. *Canning Industry*, December, 1950.

6. Doty, P. M., Aiken, W. H., and Mark, H. Water vapor permeability of organic films. *Ind. Eng. Chem., Anal. Ed.*, **16**, 686-690 (1944).

7. Du Pont de Nemours & Co. Du Pont Mylar Polyester Film. *Technical Bulletin 1-2-53*, Du Pont de Nemours & Co., Film Department, Wilmington, Delaware.

8. Kempe, L. L., Graikowski, J. T., and Brownell, L. E. Ray-sterilizing food wrapping. *Food Engineering*, **25** (11), 55-56, 174 (1953).

9. Landrock, A. H., and Proctor, B. E. Gas permeability of films. *Modern Packaging*, **25** (10), 131-135, 199-201 (1952).

10. Muldoon, T. J., Couch, R. de S., and Barnes, M. M. Organic vapor transmission test. *Modern Packaging*, **24** (5), 123-126 (1951).

11. Packaging Catalog Corporation. *Modern Packaging Encyclopedia, 1953.* Packaging Catalog Corporation, New York, N. Y.

12. Penn, W. S. Properties of plastic films. *British Packer*, Part I. Moisture Permeability, June, 1949, p. 31; Part II. Moisture Absorption, July, 1949, p. 26; Part III. Resistance to Heat, October, 1949, pp. 38, 50.

13. The Association of Vitamin Chemists, Inc. *Methods of Vitamin Assay*, 1947. Interscience Publishers, Inc., New York, N. Y.

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TECHNICAL PROGRAM AND ABSTRACTS

GENERAL AND SOCIAL EVENTS

Saturday, June 11

Executive Committee Meeting
10:00 a.m. Private Sky Room
Deshler-Hilton Hotel

OVIFT Committee Chairmen dinner meeting
6:00 p.m. Parlor 307
Deshler-Hilton Hotel

Editorial Board Meeting
7:30 p.m. Room 1337
Deshler-Hilton Hotel

Sunday, June 12

National Council Meeting
10:00 a.m. Java Room
Deshler-Hilton Hotel

Registration
10:00 a.m. Mezzanine Floor
Deshler-Hilton Hotel

Exhibits
1:00 p.m. Official Opening
Deshler-Hilton Hotel
Neil House

Ladies' Get-Acquainted Tea
3:00 p.m. Sky Room
Deshler-Hilton Hotel

Press Conference
4:00 p.m. Parlors 211, 212, 216
Deshler-Hilton Hotel

Social Hour
8:00 p.m. Grand Ball Room
Deshler-Hilton Hotel

Monday, June 13

Section Officers' Breakfast
7:30 a.m. Parlor 307
Deshler-Hilton Hotel

Registration
8:00 a.m. Mezzanine Floor
Deshler-Hilton Hotel

Opening Session
9:30 a.m. Grand Ball Room
Neil House

Ladies' Tour—Lebanon
Start at 11:00 a.m.
Assemble 10:30 a.m., Ladies' Lounge 1210-1212
Deshler-Hilton Hotel

Awards Luncheon
12 Noon Grand Ball Room
Deshler-Hilton Hotel

Ox Roast
6:00 p.m. Stadium, O. S. U.

Water Follies
9:00 p.m. Natatorium, O. S. U.

Tuesday, June 14

M. I. T. Alumni Breakfast
7:30 a.m. Town Room
Neil House

Registration
8:00 a.m. Mezzanine Floor
Deshler-Hilton Hotel

General Session
9:00 a.m. Grand Ball Room
Neil House

O. S. U. Alumni Luncheon
12 Noon Parlor 307
Deshler-Hilton Hotel

Univ. Mass. Alumni Luncheon
12 Noon Parlor B
Neil House

Ladies' Luncheon—Ilonka's
1:00 p.m.
12:30 p.m. Assemble Rooms 1210-1212
Deshler-Hilton Hotel

Appert Award Banquet
6:30 p.m. Grand Ball Room
Ohio Union, O. S. U.

Wednesday, June 15

Committee on Education Breakfast
8:00 a.m. Parlor 307
Deshler-Hilton Hotel

Registration
8:00 a.m. Mezzanine Floor
Deshler-Hilton Hotel

General Session
9:00 a.m. Grand Ball Room
Neil House

Installation Luncheon
12 Noon Junior Ball Room
Neil House

Ladies' Luncheon—Maramor
1:00 p.m.
12:30 p.m. Assemble Rooms 1210-1212
Deshler-Hilton Hotel

Phi Tau Sigma Social Hour
4:30 p.m. Parlor 307
Deshler-Hilton Hotel

Thursday, June 16

Registration
8:00 a.m. Mezzanine Floor
Deshler-Hilton Hotel

Plant Tour—Event R
8:00 a.m. Capital City Products and Westinghouse Electric Corp.

Plant Tour—Event S
8:00 a.m. The Kroger Co., and M & R Dietetic Laboratories, Inc.

Plant Tour—Event T

1:30 p.m. Battelle Memorial Institute and Food Research Laboratories Ohio State University Campus

Plant Tour—Event U

1:30 p.m. Buckeye Potato Chip Co., Omar Bakeries, and August Wagner Breweries

* * *

LADIES' PROGRAM IN THE DESHLER-HILTON

Ladies' Lounge

Rooms 1210-1212 in the Deshler-Hilton have been set aside as a lounge for women guests of the IFT. Information on all events may be obtained there, and all trips will assemble there. If you prefer independent sight-seeing or shopping, our committee will help you arrange the trips. Our general Hospitality Committee will have maps and literature about interesting local attractions.

Tickets Required for All Functions

All scheduled events will be controlled by the use of tickets which may be obtained at the Registration Desk. For those events away from the hotel it will be necessary to make a charge for the cost of transportation. Tickets must be obtained not later than the day prior to the event so that adequate transportation may be arranged. All buses leave from the Broad Street Entrance of the Deshler-Hilton.

Sunday, June 12

3–6 p.m. All ladies are invited to a Get-Acquainted Tea in the Sky Room of the Deshler-Hilton.

8–10 p.m. Social Hour for all registered persons —the Grand Ball Room, Deshler-Hilton Hotel.

Monday, June 13

11 a.m. A trip has been planned by bus across the peaceful and prosperous Ohio countryside to Lebanon for a glimpse into the riches of the Ohio heritage. Late on Monday morning, but in time to reach the Golden Lamb for lunch, those who wish to make the tour will leave the headquarters hotel, bound for the venerable city of Lebanon. After lunch at the historic old inn the group will drive to Glendower, a recently restored early American home which is the pride-and-joy of the Ohio Historical Society. On the way back to Columbus the buses will stop briefly so that the visitors may look over the extensive earthworks and take a glance at some of the mementos at Fort Ancient. The buses will get back to the hotel early enough for the travelers to take a short rest before going to the O. S. U. stadium for the big barbecue and swimming meet.

6–10 p.m. Ox-Roast and Water Follies — Stadium and Natatorium, Ohio State University Campus. Here you will get a real treat. Prof. Kunkle is known throughout the United States for his barbecues. The present O. S. U. swim team boasts of at least two swimmers who have recently broken all previous world's records.

Tuesday, June 14

1 p.m. For wonderful food and generous hospitality, central Ohio has nothing to compare with Ilonka's Party House where a luncheon has been planned for Tuesday noon. In the afternoon the lady herself will beguile her audience with tales of her adventures in search of the exotic in foods in many far countries. Later in the afternoon the group will visit the Columbus Rose Garden which should be at the height of its splendor.

6:30 p.m. Appert Award Banquet, Ball Room —Student Union, Ohio State University Campus.

Wednesday, June 15

1 p.m. No visit to Columbus would be complete without a meal at the Maramor, named for its founder, Mary Love, and known throughout its history for the highest standards of quality in food and service. Accordingly, luncheon on Wednesday noon is to be at the Maramor. This is located in the center of the business district, so the rest of the afternoon is free for browsing, shopping, movies, sightseeing, or what-you-will. The hostesses in the women's headquarters will have many suggestions for those who want to see more of Columbus or its environs. Plant trips are on Thursday and a reluctant farewell.

Thursday, June 16

One tour will start at 8:00 a. m. for the Capital City Products Co. where they specialize in the manufacture of fatty foods. From here the tour will go to the Westinghouse Electric Corporation.

Another tour, also starting at 8:00 a. m., will include Kroger's Bakery and M & R Dietetic Labs.

In the afternoon, one tour starting at 1:30 p. m., will include Battelle Memorial Institute and the Food Processing Research Facilities on The Ohio State University Campus.

Another tour, also leaving at 1:30 p. m., will include Omar Bakeries, Buckeye Potato Chip, Inc., and August Wagner Breweries.

* * *

PLANT TRIPS

Columbus is favored by many food processing plants. A few will be included in the tours scheduled for Thursday, June 16. A brief description of the

plants in the Columbus area that will be included in the tours is provided below.

In addition, numerous officials of plants in Ohio have extended invitations to members of our society to visit them before or following the Convention. It is suggested that you contact them or their representatives during the Convention and arrange to visit one or more plants on Friday following the Convention. Plants of special interest include the following:

Ohio's great Swiss cheese industry is located in the area northeast of Columbus centered around New Philadelphia.

In the area generally to the northwest of Columbus, among others are located the La Choy Food Products Division of Beatrice Foods Co., Archbold, Ohio; the Ball Brothers Co., glass food containers, at Muncie, Indiana; and the Nestle Co., milk products, Marysville, Ohio.

Just north of the city limits of Columbus in the little town of Worthington is located Worthington Foods, Inc., manufacturer of special soybean foods.

In Cincinnati are located the home laboratories and manufacturing plants of the Kroger Co. at 1212 State Avenue. At nearby Ivorydale you will find the soap and shortening manufacturing plant of the Procter and Gamble Co. where plant tours are regularly scheduled. At nearby Norwood is located the Heekin Can Co. and the Continental Can Co.

At Moraine City, just south of Dayton, Ohio, is located the Frigidaire Division of General Motors. Regular tours of the plant are scheduled. Appointment for these tours is necessary and can be made by writing to the Director of Plant Tours. The Food Technology Laboratory of the Monsanto Chemical Co. is located in Dayton.

The Shellmar-Betner Division of Continental Can Co. is located at Mt. Vernon. They manufacture and plasticize many types of food containers.

TOURS

The Ohio State University

Visitors will have an opportunity to see the beautiful new Student Union Building on Tuesday night, June 14, when they attend the Appert Award banquet. They will also see the stadium and natatorium during the ox-roast and entertainment on Monday evening, June 13.

The tour of the principal food technology laboratories scheduled for Thursday, June 16, will include the newly-acquired Ohio State University Research Center, which will house a central laboratory and facilities for cooperative research, the Horticultural laboratories located in the Horticulture and Forestry Building, the Chemical Engineering laboratories in the Chemistry Building and the Departments of Agricultural Biochemistry and Dairy Technology located in the Agricultural Laboratories Building. The Department of Dairy Technology maintains a modern dairy plant.

Battelle Memorial Institute
505 King Ave.

The world's largest private non-profit research organization. Founded in 1929. Has approximately 2200 scientists, technicians, and other personnel working on diverse projects of both a fundamental and practical nature. Fields of research endeavor include essentially all phases and types of engineering, chemistry, physics, electronics, nucleonics, engineering economics, graphic arts, and agricultural sciences. In addition to the Columbus research center, the Institute maintains two laboratories and several offices in foreign countries.

Capital City Products Co.
525 W. First Ave.

Manufacturer and processor of fatty foods. Refining, hydrogenation and processing of crude cottonseed, corn, and soya oils. Market covers eastern two-thirds of the United States. Principal products include "Dixie" margarine, "King Taste" mayonnaise and shortening, and "BBS" shortenings for bakery use.

Buckeye Potato Chip Co.
2689 E. Fifth Ave.

Manufacturer of potato chips, canned shoestring potatoes, and packaged popped corn. A small modern specialized food plant servicing central Ohio. Potato chipping capacity of about 1000 lbs. per hour.

The Kroger Co.
457 Cleveland Ave.

One of 14 bakeries operated by the Kroger Co. A large modern bakery that produces breads, cakes, crackers and cookies. The Columbus plant is one of the two Kroger plants that bake crackers and cookies. Types of crackers made are soda, oyster, and Graham. Soda cracker capacity is approximately 2200 lbs. per hour. Some 30 to 35 varieties of cookies are made in this plant. A quality control laboratory is maintained for continuous inspection of raw materials and finished products. The tour will be confined primarily to the cracker and cookie division of the bakery and the laboratory.

M & R Dietetic Laboratories, Inc.
625 Cleveland Ave.

Manufacturer of concentrated and dehydrated special food products made primarily from milk. Plant operations include concentration, spray drying, ion exchanging, and modern packaging. Plant in Columbus manufactures "Pream" and "Par-T-Kreme," two different types of dehydrated cream products, "Ten-B-Low" and "Colac," two different types of concentrated ice cream mixes, and powdered whole milk. Modern plant at Sturgis, Michigan manufactures "Similac," a substitute mother's milk. Trade area includes all of the U. S. and many foreign countries. Tour will include the plant and laboratories.

Westinghouse Electric Corporation, Electric Appliance Division
300 Philipi Road

The Nation's largest refrigerator plant. A brand new industrial plant, opened in 1954. Manufactures home refrigerators and freezers. Peak production capacity is 4000 major appliances per day. Tour will cover much of the plant, the quality testing facilities, and the splendid auditorium and display room.

Omar Bakeries
408 Sheldon Ave.

A new and very modern plant that produces breads, doughnuts, rolls, cakes, and pies. Operates one of the world's largest automatic bread ovens that turns out 7200 loaves of bread per hour. Doughnuts made at the rate of 720 dozen per hour. Operates 419 home delivery routes in the Columbus area.

August Wagner Breweries, Inc.
605 S. Front St.

Columbus' only operating brewery. Has been in continuous—yes, continuous—operation since 1905. Products are two lager beers, "Gambrinus" and "Augustiner."

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SUMMARY OF THE TECHNICAL PROGRAM

Monday, June 13

9:30 a.m. General Session — Main Ball Room, Neil House

2:00 p.m. Section A—Meats. Main Ball Room, Neil House

2:00 p.m. Section B—Research and General Papers. Junior Ball Room, Neil House

2:00 p.m. Section C—Canning and Processing. Grand Ball Room, Deshler-Hilton

2:00 p.m. Section D—Flavor and Color. Hall of Mirrors, Deshler-Hilton

Tuesday, June 14

9:00 a.m. General Session
BABCOCK-HART AWARD ADDRESS
DR. WILLIAM V. CRUESS
Main Ball Room, Neil House

10:00 a.m. Section E — Nutrition. Main Ball Room, Neil House

10:15 a.m. Section F — General Papers. Junior Ball Room, Neil House

10:15 a.m. Section G—Packaging. Hall of Mirrors, Deshler-Hilton

10:15 a.m. Section H—Microbiology. Grand Ball Room, Deshler-Hilton

2:00 p.m. Section I—Functional Value of Food Additives. Main Ball Room, Neil House

2:00 p.m. Section J—Microbiology. Junior Ball Room, Neil House

2:00 p.m. Section K—Food Engineering. Grand Ball Room, Deshler-Hilton

2:00 p.m. Section L—Vegetables. Hall of Mirrors, Deshler-Hilton

Wednesday, June 15

9:00 a.m. General Session
APPERT MEDALIST ADDRESS
DR. C. G. KING
Main Ball Room, Neil House

10:00 a.m. Section M — Radiation. Main Ball Room, Neil House

10:15 a.m. Section N—Quality Control and General. Junior Ball Room, Neil House

10:15 a.m. Section O—Fruits. Grand Ball Room, Deshler-Hilton

10:15 a.m. Section P — Fermentation. Hall of Mirrors, Deshler-Hilton

2:00 p.m. Section Q — Radiation. Main Ball Room, Neil House

2:00 p.m. Section R — Poultry. Junior Ball Room, Neil House

2:00 p.m. Section S—Frozen Foods. Grand Ball Room, Deshler-Hilton

2:00 p.m. Section T—Sensory Testing. Hall of Mirrors, Deshler-Hilton

DETAILED PROGRAM

MONDAY MORNING — JUNE 13

GENERAL SESSION
Main Ball Room—Neil House

Chairman: PRESIDENT P. K. BATES

9:30—CALL TO ORDER

9:35—GREETINGS FROM THE OHIO VALLEY SECTION
GEORGE F. GARNATZ, Chairman, O.V.S.

9:45—ANNOUNCEMENTS
H. D. BROWN, General Chairman

9:55—PRESIDENTIAL ADDRESS:
P. K BATES

10:15—THE GREAT AMERICAN CUSTOMER
S. A. DOUGLAS, Director of Sales and Advertising, The Kroger Co., Cincinnati, Ohio.

11:00—RESEARCH FOR THE GREAT AMERICAN CUSTOMER
L. L. RUMMELL, Dean, College of Agriculture, The Ohio State University and Director, The Ohio Agricultural Experiment Station, Columbus, Ohio.

11:45—ANNOUNCEMENT ON ACTIVITIES OF THE FOODS ADVISORY COMMITTEE ON CIVIL DEFENSE
ROY C. NEWTON, Chairman

MONDAY AFTERNOON — JUNE 13

Section A—Main Ball Room, Neil House
Meats

Chairman: W. J. SHANNON

2:00— 1. Post-Mortem Changes in the Ion-Protein Systems in Meat
EUGEN WIERBICKI, Dept. of Animal Science and Agricultural Biochemistry, The Ohio State University and Ohio Agr. Exp. Station, and F. E. DEATHERAGE, Dept. of Agr. Biochemistry, The Ohio State University, Columbus, Ohio.

2:25— 2. The Effect of Storage on the Composition and Nutritive Properties of Farm-Style Hams
M. D. FIELDS, Eastern Utilization Research Branch, Agr. Res. Service, U. S. Dept. of Agr. and C. F. DUNKER, Agr. Res. Center, Beltsville, Md.

2:50— 3. A Continuous Process for Smoked Meats
JACK W. HANLEY, GORDON L. MONTGOMERY, MAURICE S. RARICK, MAXWELL C. BROCKMANN, Kingan, Inc., 55 S. Blackford Street, Indianapolis, Ind.

3:15— 4. Studies on Tenderness of Beef. II. Varying Storage Times and Conditions
PAULINE C. PAUL, Home Economics Dept., University of California, Davis, Calif., and L. J. BRATZLER, Michigan State College, East Lansing, Mich.

3:40— 5. Studies on the Chemistry of Cured Meat Pigment Fading
H. N. DRAUDT, and F. E. DEATHERAGE, Dept. of Agr. Biochemistry, The Ohio State University, Columbus 10, Ohio.

4:05— 6. Compatability of Sodium Ascorbate and Sodium Nitrite in Meat Curing Mixtures
C. M. HOLLENBECK and ROSEMARIE MONAHAN, Chemical Division, Merck & Co., Inc., Rahway, N. J.

MONDAY AFTERNOON — JUNE 13

Section B—Junior Ball Room, Neil House

Research and General Papers

Chairman: D. C. McCOY

2:00— 7. Pectic Enzymes in Wine Making

W. V. CRUESS and R. QUACCHIA, Food Technology Dept., University of California, Berkeley 4, Calif.

2:18— 8. Spectrophotometric Determination of Sorbic Acid in Foods

FREDERICK H. LUCKMANN and DANIEL MELNICK, Research Laboratories, The Best Foods, Inc., Bayonne, N. J.

2:36— 9. Increasing Shelf Life of Cereals with Phenolic Antioxidants

BEN N. STUCKEY, Eastman Chemical Products, Inc. Subsidiary of Eastman Kodak Co., Kingsport, Tenn.

2:54— 10. The Trans Fatty Acid Content of Margarines and Shortenings

J. B. BROWN and A. F. MABROUK, The Ohio State University, Columbus, Ohio.

3:13— 11. Physical and Chemical Factors Influencing the Color of Potato Chips

AHMED HABIB and H. D. BROWN, Ohio Agricultural Experiment Station, Wooster, Ohio

3:30— 12. The Effect of Quaternary Ammonium Germicides on the Electrophoretic Mobility of *E. coli* in Various Salt Solutions

DAVID L. MEGGISON, JR., Central Laboratories, General Foods Corp., 400 9th St., Hoboken, N. J., and WILLIAM S. MUELLER, Dairy Industry Dept., University of Massachusetts, Amherst, Mass.

3:48— 13. Stabilized Lemonade Powder

G. K. NOTTER, D. H. TAYLOR, E. C. MARSHALL, and L. H. WALKER, Western Utilization Research Branch, Agr. Res. Service, U. S. Dept. of Agr., Albany 10, Calif.

4:06— 14. Candied Cherries — Effect of Sucrose-Invert and High Conversion Glucose Syrups

C. C. STRACHAN and F. E. ATKINSON, Canada Dept. of Agr., Fruit and Vegetable Processing Laboratory, Experimental Station, Summerland, B. C.

MONDAY AFTERNOON — JUNE 13

Section C—Grand Ball Room, Deshler-Hilton

Canning and Processing

Chairman: C. L. SMITH

2:00— 15. A Comparison of Several Methods of Heat Stabilization of Florida Frozen Orange Concentrate

R. B. GUYER and W. M. MILLER, Continental Can Co., Inc., 4645 W. Grand Avenue, Chicago, and O. W. BISSETT and M. K. VELDHUIS, U. S. Citrus Prod. Station, Winter Haven, Fla.

2:20— 16. Some Aspects of Canning Soft Drinks

H. T. JOHNSON and A. W. McALPIN, Metal Div., Research and Dev. Dept., Continental Can Co., Inc., 4645 West Grand Ave., Chicago, Ill.

2:40— 17. Factors Affecting the Rate of Chicken Meat Dehydration Under Vacuum

ALDEN YAO, A. I. NELSON, and M. P. STEINBERG, Dept. of Food Technology, University of Illinois, Urbana, Ill.

3:00— 18. Chromate Treatment of Preserving Exterior Brightness of Processed Food Containers

MAURICE SIEGEL, Strasburger & Siegel, Consulting Chemists, 1403 Eutaw Place, Baltimore 17, Md., and JOHN W. McGREW and E. C. BERTUCIO, Research and Development Division, Mutual Chemical Co. of America, 1348 Block Street, Baltimore 31, Md.

3:20— 19. The Effect of Processing Methods on the Color of Tomato Juice

R. B. DAVIS and W. A. GOULD, Dept. of Horticulture, Ohio Agricultural Experiment Station, Wooster, Ohio.

3:40— 20. Potato Flakes. A New Form of Dehydrated Mashed Potatoes. II. Some Factors Influencing Texture

J. CORDING, JR., M. J. WILLARD, JR., J. F. SULLIVAN, R. K. ESKEW, and P. W. EDWARDS, Eastern Utilization Research Branch, U. S. Dept. of Agr., 600 East Mermaid Lane, Philadelphia 18, Pa.

4:00— 21. Preparation and Storage of Canned Berry and Berry-Apple Pie Fillings

A. W. MOYLS, F. E. ATKINSON, C. C. STRACHAN, and DOROTHY BRITTON, Canada Dept. of Agr., Fruit and Vegetable Processing Lab., Experimental Station, Summerland, B. C.

MONDAY AFTERNOON — JUNE 13

Section D—Hall of Mirrors, Deshler-Hilton

Flavor and Color

Chairman: HANS LINEWEAVER

2:00— 22. Candied Fruit Metallic Discoloration

J. A. KITSON and C. C. STRACHAN, Canada Dept. of Agr., Fruit and Veg. Processing Lab., Exp. Station, Summerland, B. C.

2:20— 23. The Effect of Copper Upon the Development of Color in the Processing and Storage of Honey

E. EINSET and WALTER L. CLARK, School of Nutrition, Cornell University, Savage Hall, Ithaca, N. Y.

2:40— 24. Important Newly Developed Flavoring Aromatics

ALEXANDER KATZ, F. Ritter & Company, 4001 Goodwin Ave., Los Angeles 39, Calif.

3:00— 25. Observations on Black Pepper

FRED TAUSIG and ROY E. MORSE, Wm. J. Stange Co., 342 North Western Avenue, Chicago 12, Ill.

3:20— 26. The Effect of Water Impurities on the Flavor of Brewed Coffee

E. E. LOCKHART, C. L. TUCKER, and M. C. MERRITT, Dept. of Food Technology, Massachusetts Institute of Technology, Cambridge 39, Mass.

3:40— **27.** Organic Acids in Brewed Coffee

AHMED F. MABROUK and F. E. DEATHERAGE, Dept. of Agr. Biochemistry, The Ohio State University, Columbus 10, Ohio.

4:00— **28.** Volatile Reducing Substances (VRS) and Volatile Nitrogen Compounds in Canned Fish

LIONEL FARBER and MICHAEL FERRO, Fisheries Res. Lab., The George Wms. Hooper Foundation, University of California, San Francisco 22, Calif.

VISIT YOUR EXHIBITS

TUESDAY MORNING — JUNE 14

GENERAL SESSION
Main Ball Room, Neil House

Chairman: C. G. KING

9:00— **29.** Babcock-Hart Award Address

WILLIAM V. CRUESS, University of California, Davis.

TUESDAY MORNING — JUNE 14

Section E—Main Ball Room, Neil House

Nutrition

Chairman: C. G. KING

10:00— **30.** More Miles Per Pound of Food

ARTHUR C. AVERY, Commissary Div., U. S. Navy Commissary Res. Div., U. S. Naval Supply Res. and Dev. Facility NSD, Bayonne, N. J.

10:25— **31.** Nutrition Education—Opportunity and Responsibility

HORACE L. SIPPLE, Nutrition Foundation, Inc., Chrysler Building, New York 17, N. Y.

10:50— **32.** The Program of the Vitamin Commission of the International Union of Pure and Applied Chemistry

BERNARD L. OSER, Food Research Laboratories, Inc., 48-14, Thirty-third Street, Long Island City, N. Y.

11:15— **33.** Digestion and Absorption of Fat

F. H. MATTSON, The Procter and Gamble Company, Miami Valley Laboratories, P. O. Box 175, Cincinnati 31, Ohio.

TUESDAY MORNING — JUNE 14

Section F—Junior Ball Room, Neil House

General Papers

Chairman: H. W. SCHULTZ

10:15— **34.** Preparation of Dehydrated Pork or Reduced Glucose Content

R. L. HENRICKSON, D. E. BRADY, C. W. GEHRKE, R. F. BROOKS, Food Processing Laboratories, Missouri Agr. Exp. Station, Columbia, Mo.

10:30— **35.** The Effect of Unit Processes on the Salt and Moisture Content of Hams Processed Country-Style

RICHARD D. HAYNES, Monsanto Chemical Co., Dayton, Ohio; and HERMAN P. SCHMITT, National Association of Frozen Food Packers, Washington, D. C.

10:45— **36.** The Effect of Collagen and Palatability of Different Methods of Cooking Beef Round of Commercial and Prime Grades

RUTH M. GRISWOLD, Dept. of Home Economics, Indiana University, Bloomington, Ind.

11:00— **37.** Use of De-hulled Extracted Soybean Flakes as a Ground Meat Extender

R. PIPPITT, A. I. NELSON, and M. P. STEINBERG, University of Illinois, Dept. of Food Technology, Urbana, Ill.

11:15— **38.** Vegetable Fat Whips for Bakery and Household Use

H. W. DIAMOND, American Maize Products Co., Roby, Ind.

11:30— **39.** Studies Related to the Manufacture of Filled Milk Cheese

I. I. PETERS, Texas Agricultural Exp. Station, College Station, Tex.

TUESDAY MORNING — JUNE 14

Section G—Hall of Mirrors, Deshler-Hilton

Packaging

Chairman: R. A. FARRELL

10:15— **40.** Army Prevents Infestation of Cellophane Wrapped Rations

JOHN E. DESPAUL, The Quartermaster Subsistence Laboratory, Chicago, Ill.

10:35— **41.** Protective Packaging of Foods Against Moisture Condensation

J. G. WOODROOF, Georgia Agr. Experiment Station, Food Processing Division, Experiment, Ga.

10:55— **42.** Factors That Make Packages Talk

JOHN M. TINDALL, Waxed Paper Merchandizing Council, Inc.

11:15— **43.** Technicalities in Utilization of Limp and Thin Films on Automatic Packaging Equipment

PAUL J. VAUGHAN, Goodyear Tire and Rubber Company, Akron, Ohio.

TUESDAY MORNING — JUNE 14

Section H—Grand Ball Room, Deshler-Hilton

Microbiology

Chairman: H. H. WEISER

10:15— **44.** Use of High-Voltage Cathode Rays to Destroy Bacteria of the Salmonella Group in Powdered, Liquid, and Frozen Egg Whites

J. T. R. NICKERSON, HANS LINEWEAVER, S. E. CHARM, R. C. BROGLE, E. E. LOCKHART, and B. E. PROCTOR, Dept. of Food Technology, Massachusetts Institute of Technology, Cambridge, Mass.

10:33— **45.** Cathode Ray Irradiation of Chicken Meat for the Extension of Shelf Life

B. E. PROCTOR, J. T. R. NICKERSON, and J. J. LICCIARDELLO, Dept. of Food Technology, Massachusetts Institute of Technology, Cambridge 39, Mass.

10:51— **46.** Studies on the Sensitivity of Food Spoilage Microorganisms to Various Antibiotics

F. S. GIBSON, A. R. KOHLER, and L. R. HINES, Nutrition and Physiology Section,

American Cyanamid Company, Research Div. Lederle Labs., Pearl River, N. Y.

11:09— 47. Observations on Antibiotics in a Market Milk Supply and the Effect of Certain Antibiotics on the Keeping Quality of Milk

K. M. SHAHANI, I. A. GOULD, H. H. WEISER, and W. L. SLATTER, The Ohio State University, Dept. of Dairy Husbandry, Columbus 10, Ohio.

11:27— 48. Characteristics of Insect Infestation in Natural Condition Raisins

JOHN H. KILBUCK and GEORGE REILLY, Dried Fruit Association of California, P. O. Box 86, Fresno, Calif.

TUESDAY AFTERNOON — JUNE 14

Section I—Main Ball Room, Neil House

Functional Value of Food Additives

Chairman: B. L. OSER

2:00— 49. Survey of Chemicals Used in Food Processing

D. B. HAND, New York State Agricultural Experiment Station, Geneva, N. Y.

2:30— 50. Flavomatics in Food

H. L. JANOVSKY, Virginia Dare Extract Co., Inc., 882 3rd Avenue, Brooklyn, N. Y.

3:00— 51. Legislative Control of Pesticidal Chemicals

LEA S. HITCHNER, Exec. Sec., National Agr. Chemicals Association, 1145 19th St., N. W., Washington 6, D. C.

3:30— 52. Chemical Additives and the Federal Food, Drug, and Cosmetic Act

GEORGE P. LARRICK, Food and Drug Administration, Dept. of Health, Education and Welfare, Washington 25, D. C.

TUESDAY AFTERNOON — JUNE 14

Section J—Junior Ball Room, Neil House

Microbiology

Chairman: J. C. AYRES

2:00— 53. The Direct Microscopic Enumeration of Bacteria in the Washings of Green Beans

J. ORVIN MUNDT, Dept. of Bacteriology, University of Tennessee, Knoxville, Tenn.

2:18— 54. Species of *Clostridium* Associated with "Zapatera," a Malodorous Fermentation of Olives

TOSHIO KAWATOMARI and REESE H. VAUGHN, Dept. of Food Technology, University of California, Davis, Calif.

2:36— 55. Changes in the Yeast Flora of Olive Brines

E. M. MRAK, REESE H. VAUGHN, MARTIN W. MILLER, and H. J. PHAFF, Dept. of Food Technology, Univ. of California, Davis, Calif.

2:54— 56. Thermal Resistance Determinations in Steam Using Thermal Death Time Retorts

C. F. SCHMIDT, J. H. BOCK, and J. A. MOBERG, Metal Div., Research and Dev. Dept., Continental Can Co., Inc., 4645 W. Grand Ave., Chicago, Ill.

3:12— 57. Heat Activation of Bacterial Spores

N. W. DESROSIER and F. HEILIGMAN, Agr. Exp. Station, Purdue University, Lafayette, Ind.

3:30— 58. Activators and Inhibitors of Spore Germination

F. HEILIGMAN and N. W. DESROSIER, Agr. Exp. Station, Purdue University, Lafayette, Ind.

3:48— 59. Interactions Between Ascorbic Acid and Psychrophilic Bacteria Associated with the Discoloration of Prepackaged Beef

R. N. COSTILOW, BADI A. BATSHON, L. J. BRATZLER, and D. A. ROBACH, Depts. of Microbiology and Public Health and of Animal Husbandry, Michigan State College, East Lansing, Mich.

4:06— 60. Sorbic Acid as a Fungistatic Agent at Different pH Levels for Molds Isolated from Strawberries and Tomatoes

E. S. BENEKE, Dept. of Botany and Plant Pathology, and F. W. FABIAN, Dept. of Microbiology and Public Health, Michigan State College, East Lansing, Mich.

TUESDAY AFTERNOON — JUNE 14

Section K—Grand Ball Room, Deshler-Hilton

Food Engineering

Chairman: F. K. LAWLER

2:00— 61. Food Engineering Award Address
The Peebles Instant Milk Process

D. D. PEEBLES, Western Condensing Co., Petaluma, Calif.

2:25— 62. Engineering Approach to Food Processing Problems

HORACE L. SMITH, JR., Consultant, Richmond, Va.

2:50— 63. Operations Research — Applications in Food Technology

JACK C. LEONARD, Senior Associate and GEORGE D. CREELMAN, President, Creelman Associates, 2245 Harcourt Drive, Cleveland 6, Ohio.

3:10— 64. Experimental Production of Tomato Powder by Spray Drying

M. E. LAZAR, A. H. BROWN, G. S. SMITH, F. WONG, and F. E. LINDQUIST, Agr. Res. Service, U. S. Dept. of Agr., 800 Buchanan St., Albany 10, Calif.

3:30— 65. Engineering Air Removal from Non-Processed Foods in Metal Cans

H. D. BAKER and J. M. HEINEN, JR., Metal Div., Res. and Dev. Dept., Continental Can Co., Inc., 4645 W. Grand Avenue, Chicago, Ill.

3:50— 66. A Flow Meter for the Food Industry

LYLE M. RICHARDSON, The Foxboro Company, Foxboro, Mass.

4:10— 67. Flexible Automatic Retort Control System

GRANVILLE BARNUM, JOHN BARBER, and LESLIE VAN HUBEN, Taylor Instrument Companies, 95 Ames Street, Rochester 1, N. Y.

TUESDAY AFTERNOON — JUNE 14

Section L—Hall of Mirrors, Deshler-Hilton

Vegetables

Chairman: C. H. MAHONEY

2:00— 68. Effect of Cellulosic Materials on the Consistency of Tomato Juice

R. T. WHITTENBERGER and G. C. NUTTING, Eastern Utilization Research Laboratory, U. S. Dept. of Agr., Philadelphia 18, Pa.

2:15— 69. A Comparison of the Stability of Canned Concentrated Tomato Juice and Canned Single-Strength Tomato Juice

ALBERT C. RAUCH and IVOR T. NII, Qm. Food and Container Institute for the Armed Forces, 1819 W. Pershing Road, Chicago 9, Ill.

2:30— 70. Stability of Dehydrated Potato Products

C. E. HENDEL and H. K. BURR, Western Utilization Research Branch, U. S. Dept. of Agr., Albany 10, Calif.

2:45— 71. Observations on Pre-Peeling of Potatoes

R. L. OLSON, P. C. MAYER, W. O. HARRINGTON, W. R. MULLINS, and A. L. POTTER, JR., Western Utilization Research Branch, U. S. Dept. of Agr., Albany 10, Calif.

3:00— 72. Effect of Sugar Syrup Level on the Quality of Canned Sweet Potatoes

IVOR T. NII and ALBERT C. RAUCH, Qm. Food and Container Institute for the Armed Forces, 1819 W. Pershing Road, Chicago, Ill.

3:15— 73. Studies on the Dehydration of Lima Beans

A. I. NELSON, M. P. STEINBERG, H. W. NORTON, C. C. CLEVEN, Dept. of Food Technology, Univ. of Illinois, Urbana, Ill., and H. W. FRITZSCHE, Qm. Food and Container Insttiute for the Armed Forces, Chicago, Ill.

3:30— 74. Factors Affecting the Uptake and Distribution of Sulphite in Sweet Corn During Preparation and Dehydration

R. E. HAYES, A. I. NELSON, and M. P. STEINBERG, Dept. of Food Technology, University of Illinois, Urbana, Ill.

3:45— 75. The Effect on the Flavor of Canned and Frozen Asparagus of the Herbicide, Karmex-W

ELIZABETH F. STIER and W. A. MACLINN, Food Technology Dept., Rutgers University, New Brunswick, N. J.

4:00— 76. Preparation of Tasty Vegetable Products by Deep Fat Frying

EDWARD G. KELLEY and REBA R. BAUM, Eastern Utilization Research Branch, U. S. Dept. of Agr., Philadelphia 18, Pa.

VISIT YOUR EXHIBITS

WEDNESDAY MORNING — JUNE 15

GENERAL SESSION

9 A. M., Main Ball Room, Neil House

Chairman: J. M. JACKSON

9:00— 77. Appert Award Address

CHARLES GLEN KING, The Nutrition Foundation.

WEDNESDAY MORNING — JUNE 15

Section M—Main Ball Room, Neil House

Radiation

Chairman: Z. I. KERTESZ

10:00— 78. Extension of Food Storage Life by Irradiation

B. E. PROCTOR, J. T. R. NICKERSON, J. J. LICCIARDELLO, S. A. GOLDBLITH, and E. E. LOCKHART, Dept. of Food Technology, Massachusetts Institute of Technology, Cambridge, Mass.

10:20— 79. The Effect of Gamma Radiation on the Baking Quality of Some Wheat Flours

L. E. BROWNELL and H. A. HARLIN, University of Michigan, Ann Arbor, Mich.

10:40— 80. Studies in the Cold Sterilization of Liquid Foods Using Mercury Resonance Radiation. I. Milk

JAMES J. ALBRECHT, HARRY E. GUNNING, and MILTON E. PARKER, Illinois Institute of Technology, 3300 So. Federal St., Chicago, Ill.

11:00— 81. The Effects of Ionizing Radiations on the Protein Component of Foods

F. J. MCARDLE and N. W. DESROSIER, Indiana Agr. Exp. Station, Purdue University, Lafayette, Ind.

11:20— 82. Applications of Radioisotope Techniques to Commissary Research

M. M. JOSELOW, Commissary Research Division, U. S. Naval Supply Res. and Dev. Facility, Bayonne, N. J.

WEDNESDAY MORNING — JUNE 15

Section N—Junior Ball Room, Neil House

Quality Control and General Papers

Chairman: R. E. MORSE

10:15— 83. Broadening the Quality Control Program

J. M. JURAN, Consulting Management Engineer, Tuckahoe, N. Y.

10:40— 84. Quality Control on Meat Products

A. P. FOWMAN, Oscar Mayer Co., Madison, Wis.

11:05— 85. Adaptation of Agtron (Model F, to Continuous Color Measurement of Tomato Juice

JAMES O. MAVIS and WILBUR A. GOULD, The Ohio State University, Columbus 10, Ohio.

11:20— 86. Effect of Time-Temperature History on the Ascorbic Acid Content of Consumer-Size Commercially Packed Frozen Strawberries

D. G. GUADAGNI and C. C. NIMMO, Western Utilization Research Branch, U. S. Dept. of Agr., Albany 10, Calif.

11:35— 87. Effect of Time-Temperature History on Color Distribution in Commercially Packed Consumer-Size Frozen Raspberries

D. G. GUADAGNI and C. C. NIMMO, Western Utilization Research Branch, Agr. Research Serv., U. S. Dept. of Agr., Albany 10, Calif.

WEDNESDAY MORNING — JUNE 15

Section O—Grand Ball Room, Deshler-Hilton

Fruits

Chairman: R. D. GERWE

10:15— 88. Factors in Processing Methods Which Affect the Quality of Dehydrofrozen Apple Slices

L. H. WALKER, M. J. POWERS, and D. H. TAYLOR, Western Utilization Research Branch, Agr. Res. Service, U. S. Dept. of Agr., Albany, Calif.

10:33— 89. Dehydrofrozen Apricots

M. J. POWERS, W. F. TALBURT, D. H. TAYLOR, and L. H. WALKER, Western Utilization Research Branch, Agr. Res. Service, U. S. Dept. of Agr., Albany, Calif.

10:51— 90. Color Changes in Strawberry Jellies

R.V. DECAREAU, G. E. LIVINGSTON, and C. R. FELLERS, Dept. of Food Technology, University of Massachusetts, Amherst, Mass.

11:09— 91. Volatile Reducing Substances in Canned Bartlett Pears

BOR SHIUN LUH, S. J. LEONARD, D. PATEL, and L. L. CLAYPOOL, University of California, Davis, Calif.

11:27— 92. Role of Organic Acids, Sugars and Pectin on Quality of Canned Bartlett Pears

CHARLES DAME, JR., SHERMAN J. LEONARD, and BOR SHIUN LUH, Dept. of Food Technology, University of California, Davis, Calif.

WEDNESDAY MORNING — JUNE 15

Section P—Hall of Mirrors, Deshler-Hilton

Fermentation

Chairman: W. B. ESSELEN, JR.

10:15— 93. Fermentation and Curing of Cucumbers in Low Salt Brines

CARL S. PEDERSON and MARGARET N. ALBURY, N. Y. State Agr. Experiment Station, Cornell University, Geneva, N. Y.

10:30— 94. Further Studies on the Curing of Cucumbers and the Development of Green Colour in Finished Pickles

A. H. JONES and W. E. FERGUSON, Bacteriology Division, Science Service, Dept. of Agr., Ottawa, Can.

10:45— 95. The *Bacillus macerans-polymyxa* Group of Bacteria and Softening of Cucumbers and Olives

REESE H. VAUGHN, CHARLES W. NAGEL, IRA J. MEHLMAN, and GEORGE K. YORK, Dept. of Food Technology, University of California, Davis, Calif.

11:00— 96. A Study of the Acid-Forming Bacteria from Cucumber Fermentations in Michigan

R. N. COSTILOW, F. M. COUGHLIN, D. L. ROBACH, and H. S. RAGHEB, Dept. of Microbiology and Public Health, Michigan State College, East Lansing, Mich.

11:15— 97. Stability of Cucumber Peroxidase in Salt Pickles During Curing, Freshening and Packing

EDWARD E. ANDERSON, RAUNO A. LAMPI, and W. B. ESSELEN, Food Technology Dept., University of Massachusetts, Amherst, Mass.

11:30— 98. Growth and Pectolytic Activity of Some Tomato Molds at Different pH Levels

H. S. RAGHEB and F. W. FABIAN, Dept. of Microbiology and Public Health, Michigan State College, East Lansing, Mich.

VISIT YOUR EXHIBITS

WEDNESDAY AFTERNOON — JUNE 15

Section Q—Main Ball Room, Neil House

Radiation

Chairman: R. G. TISCHER

2:00— 99. Current Status of U. S. Army Quartermaster Radiation Sterilization Program

R. G. TISCHER, Qm. Food and Container Institute for the Armed Forces, 1819 West Pershing Road, Chicago 9, Ill.

2:30—100. An Evaluation of Radiation Sources as Means for Processing Foods

BELMONT S. EVANS, JR., Lt. Col., Qm. Food and Container Institute, 1819 W. Pershing Road, Chicago, Ill.

3:00—101. Nutritional and Biochemical Effects of Radiation

C. G. KING, The Nutrition Foundation, Chrysler Building, New York, and R. R. BECKER, Dept. of Chemistry, Columbia University, New York.

3:30—102. Effect of Irradiation on the Spores and Toxin of *Clostridium botulinum*

G. M. DACK and R. O. WAGENAAR, University of Chicago, Food Research Institute, Chicago, Ill.

4:00—103. Concomitant Use of Radiation with Other Processing Methods

H. W. SCHULTZ, R. F. CAIN, H. C. NORDAN, Oregon State College, Corvallis, Ore., and BRUCE H. MORGAN, Qm. Food and Container Institute for the Armed Forces, Chicago, Ill.

WEDNESDAY AFTERNOON — JUNE 15

Section R—Junior Ball Room, Neil House

Poultry

Chairman: G. F. STEWART

2:00—104. Effect of Pretreatment and Type of Packaging Material on the Quality of Fresh and Frozen Broilers

AGNES FRANCES CARLIN, ROSE MARIE VALDES, and OWEN COTTERILL, Iowa Agricultural Experiment Station, Ames, Iowa.

2:18—105. Effect of Fluctuating Temperatures on Frozen Turkeys

A. A. KLOSE, M. F. POOL, and HANS LINEWEAVER, Western Utilization Research Branch, Agr. Research Service, U. S. Dept. of Agr., Albany, Calif.

2:36—106. Tenderness in Poultry Meat. I. An Improved Method of Measuring

J. K. CAMERON and E. A. RYAN, Birds Eye Division, General Foods Corporation, Pocomoke City, Md.

2:54—107. The Production of Poultry Specialty Items

C. H. KOONZ, M. I. DARROW, and E. O. ESSARY, Swift and Company Research Laboratories, Union Stock Yards, Chicago 9, Ill.

3:12—108. A New Test for Thermostabilized Eggs

SOCRATES A. KALOYEREAS, Louisiana State University, Baton Rouge, La.

3:30—109. The Influence of Environment on Lysozyme Activity in Shell Eggs

A. A. KRAFT and A. W. BRANT, Animal and Poultry Husbandry Research Branch, Agr. Research Service, U. S. Dept. of Agr., Beltsville, Md.

3:48—110. The Monomolecular Surface Film Method for Determining Small Quantities of Yolk or Fat in Egg Albumen

DWIGHT H. BERGQUIST and FRANK WELLS, Henningsen, Inc., Springfield, Mo.

4:06—111. The Physical and Functional Properties of Lyophilized Whole Egg, Yolk and White

THOMAS ROLFES, PATRICIA CLEMENTS and A. R. WINTER, Dept. of Poultry Science, The Ohio State University, Columbus, Ohio.

WEDNESDAY AFTERNOON — JUNE 15

Section S—Grand Ball Room, Deshler-Hilton

Frozen Foods

Chairman: H. P. SCHMITT

2:00—112. Determination of Enthalpies Involved in Food Freezing

H. C. MANNHEIM, M. P. STEINBERG, and A. I. NELSON, Dept. of Food Technology, University of Illinois, Urbana, Ill.

2:20—113. Effects of Pre-Freezing Delay and Other Factors on the Drained Weight of Frozen RSP Cherries

EDWARD C. DRYDEN, JAMES F. ROBINSON, and CLAUDE H. HILLS, Eastern Utilization Research Brench, Agr. Res. Service, U. S. Dept. of Agr., Philadelphia 18, Pa.

2:40—114. Loss of Natural Glutamate in Fresh Green Peas and Other Frozen Vegetables

C. F. EVERS, R. COCROFT, and E. B. ADAMIC, International Minerals and Chemical Corporation, 20 No. Wacker Drive, Chicago 6, Ill.

3:00—115. The Effect of Sunlight on Crude Lipids Extracted from Fresh and Frozen Vegetables

FRANK A. LEE, N. Y. State Agr. Experiment Station, Cornell University, Geneva, N. Y.

3:20—116. Studies on the Preservation of Bread by Freezing

H. S. OLCOTT, J. W. PENCE, and D. K. MECHAM, Western Utilization Research Branch, U. S. Dept. of Agr., Albany, Calif.

3:40—117. Deteriorative Changes in Frozen Shrimp and Their Inhibition

MARIAN B. FAULKNER and BETTY M. WATTS, Dept. of Food and Nutrition, The Florida State University, Tallahassee, Fla.

4:00—118. Effect of Post Mortem Chilling on the Keeping Quality of Frozen Pork

DOROTHY L. HARRISON, J. L. HALL, and D. L. MACKINTOSH, Depts. of Foods and Nutrition, Chemistry, and Animal Husbandry, Kansas State College, Manhattan, Kan.

WEDNESDAY AFTERNOON — JUNE 15

Section T—Hall of Mirrors, Deshler-Hilton

Sensory Testing

Chairman: DEAN FOSTER

2:00—119. Knowledge of the Stimulus Variable as an Aid in Discrimination Tests

ELSIE L. RAFFENSPERGER and FRANCIS J. PILGRIM, Qm. Food and Container Institute for the Armed Forces, 1819 West Pershing Road, Chicago, Ill.

2:20—120. Variations in Preference Ratings for Foods Served at Meals

DAVID R. PERYAM and NORMAN J. GUTMAN, Qm. Food and Container Institute for the Armed Forces, 1819 West Pershing Road, Chicago, Ill.

2:40—121. The Taste and Odor of Water in D-Units, as a Standard Measure for Acceptance

W. FRANKLIN DOVE, University of Illinois, College of Medicine, and Illinois State Department of Public Health, Chicago 12, Ill.

3:00—122. The Establishment and Use of a Consumer Taste Panel for the Evaluation of Quality of Experimental Foods

W. A. GOULD, JANE STEPHENS, GILBERT DUVERNAY, JUDITH FEIL, INEZ PRUDENT, and RALPH SHERMAN, The Institute of Nutrition and Food Technology, The Ohio State University, Columbus, Ohio.

3:20—123. Application of Statistical Procedures to Ranking of Seven Tomato Juice Samples

ELIZABETH R. WOOD, T. A. JEEVES, MARVEL-DARE F. NUTTING, and H. K. BURR, Western Utilization Research Branch, U. S. Dept. of Agr., Albany, Calif.

3:40—124. Organoleptic Evaluation of Apple Sauce Fortified with Essence and Citric Acid

M. L. BUCH, E. C. DRYDEN, Eastern Utilization Research Branch, U. S. Dept. of Agr., JAMES R. OYLER, Knouse Foods Coop., Inc., Peach Glen, Pa., and CLAUDE H. HILLS, Eastern Utilization Research Branch, USDA, Philadelphia 18, Pa.

4:00—125. The Effects of Cooling and Freezing Procedures on Consumer Acceptability of Turkey Meat

J. V. SPENCER, W. E. MATSON, M. C. AHRENS, and W. J. STADELMAN, State College of Washington, Pullman, Wash., and U. S. Department of Agriculture.

4:06—126. Rentention of Taste Sensitivity

DONALD A. BRANDT and E. PAUL HUTCHISON, Schenley Distillers, Inc., Cincinnati, Ohio.

4:24—127. Simultaneous vs. Successive Presentation in a Paired Comparison Situation

NOEL SCHWARTZ and CORNELIA PRATT, U. S. Testing Co., Inc., Hoboken, N. J.

ABSTRACTS

1

POST-MORTEM CHANGES IN THE ION-PROTEIN SYSTEMS IN MEAT

EUGEN WIERBICKI and F. E. DEATHERAGE
Departments of Animal Science and Agricultural Biochemistry
Ohio State University and Ohio Agr. Expt. Station
Dept. of Agr. Biochemistry, The Ohio State University
Columbus 10, Ohio

Post mortem changes in muscle plasma proteins—in the ions extractable by water and in the ions expressed in the juice on cooking—will be discussed. Evidence will be presented which indicates that tenderness, changes in tenderness, shrinkage and drip on freezing may be related not only to the meat proteins and post mortem changes in these proteins but also to certain ion-protein interactions.

2

THE EFFECT OF STORAGE ON THE COMPOSITION AND NUTRITIVE PROPERTIES OF FARM-STYLE HAMS

M. D. FIELDS and C. F. DUNKER
Meat Section, Eastern Utilization Research Branch
Agric. Res. Service, U. S. Dept. of Agriculture
and
Agricultural Research Center
Beltsville, Maryland

A study was conducted on the composition, nutritive value, and keeping quality of hams dry-cured with salt only. The hams were cured and smoked and then stored at 40°, 70°, and 90° F., for 6 weeks, 6 months, and 12 months. Results showed that weight losses occurred during storage, depending on time, temperature, and relative humidity. It was shown that the salt content of farm-style hams varied widely, indicating a need for a technique to produce a more uniform product. The protein, fat, ash, and chloride content increased to the degree that hams became dehydrated during storage. Appreciable increases in amounts of soluble and non-protein nitrogenous compounds occurred only in a sample stored at 90° F. for 12 months. A considerable amount of fat hydrolysis occurred in hams stored at 70° and 90° F. for 12 months. The processing and storage of the hams had no detrimental effects upon the nitrogen efficiency value. There was no deterioration of riboflavin and niacin but there was a reduction in thiamin content during processing and storage. Hams stored at 40° F. aged slightly during 12 months storage; those stored at 70° F. deteriorated appreciably on storage of 6 months or longer; and those stored at 90° F. were scored *undesirable* after 6 months' storage. The hams were in general wholesome from the standpoint of numbers and types of bacteria, indicating bacterial contamination was not the decisive factor determining the edible storage life of the hams.

3

A CONTINUOUS PROCESS FOR SMOKED MEATS

JACK W. HANLEY, GORDON L. MONTGOMERY,
MAURICE S. RARICK, MAXWELL C. BROCKMANN
Kingan Inc., 55 S. Blackford Street
Indianapolis, Indiana

A continuous process for the production of smoked meats has been developed and utilized on a commercial scale. The process combines infrared heating and electrostatic deposition of smoke. Smoke deposition is controlled by the voltage imposed on the ionizing equipment, conveyor speed, and the density of smoke entering the smoking section. Retention time in the smoking section is 2-4 minutes. Heating is controlled by the power input to each infrared oven and conveyor speed. In the case of bacon, cured bellies are suspended from a conveyor which requires 25-40 minutes to pass through the entire process. The precise time requirement depends on the weight class of the belly. With respect to flavor, external appearance, internal color, resistance to deterioration, yield, and all other important characteristics, bacon processed in the continuous system is indistinguishable from the product produced in a conventional smokehouse. Improved efficiency of handling made possible by the continuous process reduces labor cost for smokehouse operation by 50%.

Jowls are processed by a method similar to that used for bacon. The system has proved thoroughly satisfactory for the production of smoked picnics and hams for canning, and for smoked boiled ham, smoked ribs, and smoked meats for incorporation into loaves and sausages.

A description of the system together with the operating conditions and results with various smoked products are described.

4

STUDIES ON TENDERNESS OF BEEF. II. VARYING STORAGE TIMES AND CONDITIONS

PAULINE C. PAUL * and L. J. BRATZLER
Department of Foods and Nutrition, and Animal Husbandry
Michigan State College
East Lansing

Eight pairs of *Longissimus dorsi* muscles from prime, good, and commercial grade beef animals were used to study the effects of various cold storage and freezing and thawing treatments on cooking time, cooking losses, and shear tenderness of steaks fried in deep fat.

As expected, increased length of cold storage increased the tenderness of the steaks. Any handling of the muscle, such as removal from the carcass before or during storage, or cutting of the muscle on the carcass, interfered with the tenderizing process and resulted in less tender steaks than those aged in the normal manner on the carcass.

Additional cold storage or freezing of the steaks after 3 days aging on the carcass increased the tenderness. Within the time studied (0,1 or 2 days additional storage) cold storage was nearly as effective as freezing and thawing in increasing the tenderness. Frozen steaks cooked without thawing were less tender than those thawed before cooking.

In most of the muscles, the anterior and posterior portions differed in tenderness, the anterior being the more tender in the majority of cases. There was also considerable variation in individual steaks within each portion, suggesting the need for careful consideration in selecting samples for comparability when planning experiments. Normal (on carcass) cold storage of 7 to 9 days after slaughter tended to minimize these variations. Also, the variations were more pronounced in beef of lower grade.

Significant differences in cooking time and losses were found among the various treatments. The high correlation between cooking time and losses indicated that one of the major factors affecting cooking loss was the time required to cook the steak.

* Present address: Home Economics Department, University of California, Davis, California.

5

STUDIES ON THE CHEMISTRY OF CURED MEAT PIGMENT FADING

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The fading of the red color of cured meats in the light has become a serious problem to the meat packing industry, due to the widespread use of self-service merchandising.

The desirable pigment of unheated cured meat is nitric oxide myoglobin, but since many cured meat products are heated during their manufacture, purified heat denatured nitric oxide myohemochromogen was used in a study of the fading reaction. In general, the work to be discussed was carried out using the purified heated pigment in simple chemical systems and using Warburg manometric equipment adapted to photochemical studies.

Nitric oxide was rapidly lost from the pigment in the presence of oxygen and light. This splitting off of nitric oxide proceeded at a low but measurable rate in the dark in the presence of oxygen. The nitric oxide lost from the pigment appeared as the nitrite and nitrate ions. Oxygen up-take was associated both with the oxidation of the nitric oxide and with the oxidation of the protein part of the pigment molecule.

In the simple systems used, denatured globin myohemochrome appeared as an intermediate after loss of the nitric oxide. In

the presence of light and oxygen this myohemochrome underwent further oxidation of the protein with darkening. Extended oxidation of the intermediate resulted in loss of its ability to reform the nitric oxide derivative.

6

COMPATIBILITY OF SODIUM ASCORBATE AND SODIUM NITRITE IN MEAT CURING MIXTURES

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The indophenol procedure for the determination of ascorbic acid and sodium ascorbate was made applicable to samples containing sodium nitrite. The A.O.A.C. method for the determination of nitrite was modified to eliminate the interference of ascorbic acid. Using these methods of analysis, the compatibility of sodium nitrite and ascorbate in dry and liquid curing mixtures was ascertained. The reaction rate between ascorbate and sodium nitrite was found to be influenced by not only the pH of the mixture but also the salt (NaCl) and the moisture content. The two substances were found to be quite compatible in wet curing mixtures in the pH range of 6 to 7.5, with high salt concentration, and at the usual refrigerated temperatures. Sodium ascorbate and sodium nitrite are quite compatible in dry curing mixtures even at pH below 6, providing the mixtures are kept dry.

7

PECTIC ENZYMES IN WINE MAKING

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In 1936, research was begun in this laboratory on the use of pectic enzymes for the clarification of new wines, and it has been continued intermittently to the present. One recent problem studied was that of effect of the enzymes on the methanol content of wines, as hydrolysis of pectin liberates some CH_3OH. The amounts found in the enzyme treated wines were very small, ranging from 0.004 to 0.026 g. per 100 c.c.; far below the legal limit. The treated wines become clear very much sooner than the untreated and the sediment (lees) at first racking is very much more compact and of smaller volume than that of the untreated wines. The enzyme treated wines age more rapidly than the untreated and thus may be bottled much earlier than the untreated. Usually they possess more aroma and bouquet than the untreated. Pectic enzymes are now in commercial use in a number of wineries in the U.S.A. and Australia.

8

SPECTROPHOTOMETRIC DETERMINATION OF SORBIC ACID IN FOODS

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Analyses conducted on 10 lots of commercially available sorbic acid, selected at random, have indicated that this fungistatic agent is 100% pure (S.D. $\pm$ 0.6%) when calculated to a moisture-free basis. A specification, describing this product and providing methods of assay, has been prepared. The spectrophotometric method for determining sorbic acid in cheese has been extended to permit analyses of other food products which might be supplemented with this fungistatic agent. These included baked products, fruit juices and concentrates, flavoring syrups, bread spreads, and other foods, supplemented with 0.025 or 0.10% sorbic acid. In analyzing distillates spectrophotometrically for sorbic acid content, correction is made for irrelevant light-absorbing materials contributed by the same size aliquot of the control unsupplemented product. Spectrophotometric absorption curves for control and test samples will be presented together with data on the recovery of the added sorbic acid. The importance of keeping sample size at a minimum and depend upon minimal dilutions for desired sensitivity will be supported by the experimental findings.

9

INCREASING SHELF LIFE OF CEREALS WITH PHENOLIC ANTIOXIDANTS

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Phenolic antioxidants such as butylated hydroxyanisole, butylated hydroxytoluene, and propyl gallate have proved their usefulness in preventing oxidative rancidity of animal and vegetable fats. Their use is now being extended to cereals and cereal products. The effect of these antioxidants on rice, wheat, corn, oat, and barley products is shown. A method for applying these antioxidants under factory conditions is described as well as a method for analyzing the finished cereal for antioxidant content.

10

THE TRANS FATTY ACID CONTENT OF MARGARINES AND SHORTENINGS

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Several margarines and shortenings have been examined by ultraviolet and infrared spectroscopy. Infrared absorption at 10.36μ has been used to evaluate the trans fatty acid content of the original shortenings, the mixed methyl esters and ester fractions obtained by fractional distillation and low temperature crystallization. It is shown that both margarines and shortenings prepared from hydrogenated fats contain 25 to 38% of trans acids. These belong principally to the C_{18} series but are also found in the C_{16} and C_{20} fractions. Concentrates of the trans acids were prepared by crystallizing the C_{18} esters at low temperature. It is shown that ultraviolet results after alkali isomerization are erroneous due to the presence of acids in the hydrogenated products with double bonds so positioned as to not re-arrange two conjugated diene systems.

11

PHYSICAL AND CHEMICAL FACTORS INFLUENCING THE COLOR OF POTATO CHIPS

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The color of potato chips is attributed to two main types of reactions: carbonylamino reactions known conventionally as the Maillard or browning reaction and the caramelization of the polyhydroxycarbonyl compounds, especially the reducing sugars. Quantitative analysis of 5 varieties of potatoes indicates that reducing sugars, free amino acids, and moisture contents of the potato tubers are the important factors affecting the color of the chips. From paper chromatography tests it is apparent that the kind and amount of reducing sugars and free amino acids differ widely between the various varieties included in this study. Varieties producing light-colored chips, like Russet Rural and Red Kote, contain low amounts of aldoses and basic amino acids. On the other hand, varieties producing dark brown chips, like Red Pontiac, contain larger amounts of these reactants. Katahdin fall in between these two extremes. The analysis of the 2 varieties, Red Kote and Red Pontiac, which produce light and dark chips, respectively, furnish further evidence for the influence of amino compounds on color. Both varieties have low specific gravity and practically identical contents of reducing sugars, but differ in the content of amino acids, the latter containing higher amounts than the first. Furthermore, within a certain variety, the nitrogen level at which the potatoes are grown influences the chemical composition of the tubers, especially with regard to the amount and kind of reducing sugars and amino acids. The Katahdin variety grown at a high nitrogen level contains lesser amounts of the reducing sugars and amino acids in general and aldoses and basic amino acids in particular, compared to the same variety grown at a low nitrogen level. Thus better chips are produced from Katahdin potatoes grown at a high nitrogen level.

Frying, started at 375° F., produced chips of lower fat and moisture contents and lighter pigments as compared to frying at

either 350° or 400° F. These observations involve an endpoint determined by bubble cessation. Color determination by the Hunter Color and Color Difference Meter indicates that of the three color attributes, value is the one undergoing the greatest change, while hue and chroma change only in a very narrow range.

12

THE EFFECT OF QUATERNARY AMMONIUM GERMICIDES ON THE ELECTROPHORETIC MOBILITY OF E. COLI IN VARIOUS SALT SOLUTIONS

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E. coli was suspended in solutions containing cations known to interfere with the germicidal action of quaternaries. Bacterial mobilities in these solutions were measured using an Abramson horizontal microelectrophoresis cell. Cations studied were the hydrogen, potassium, calcium, aluminum, and thorium ions. They all lowered the electronegativity at the surfaces of the bacteria. This effect increased with cationic valence. The addition of germicidal levels of quaternary caused further mobility changes, depending on the cations present. There is some indication that cations which interfere with quaternary germicidal activity do so, at least in part, by attaching themselves to bacterial surfaces, thus preventing contact between quaternary and bacteria.

13

STABILIZED LEMONADE POWDER

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Methods for preparation of lemonade powder and the storage characteristics of this product have been investigated. The powder is made by dehydrating a mixture of lemon juice concentrate, sucrose, and lemon juice sacs in a vacuum shelf drier to a moisture level of about 2%. The product is vacuum packed in a low-humidity atmosphere together with lemon oil locked in a solid carrier and an in-package desiccant. Upon reconstitution the product compares favorably in flavor and color with lemonade prepared from fresh lemons. The effects of pressure, product temperature, and time in the drier upon product quality were studied. A fairly short drying cycle for shelf-type vacuum driers is suggested. The effects of various additives and of various initial moisture levels upon the flavor, color, and vitamin retention after storage at +70° F. and +100° F. were studied, along with rates of desiccation during conditioning periods at various temperatures, flavor stability during conditioning, and equilibrium moisture contents at various relative humidities.

14

CANDIED CHERRIES—EFFECT OF SUCROSE-INVERT AND HIGH CONVERSION GLUCOSE SYRUPS

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A study was made of the effect of sucrose-invert sugars alone or in combination with high conversion glucose syrups in the manufacture of candied cherries. The fruit was processed by the hot continuous method in syrups containing only sucrose-invert sugar (ratio of sucrose to invert, 2:1 to 1:1), and in syrups in which 10, 20, 30 and 50% of the total soluble solids were derived from glucose. The sucrose-invert lots were judged the best in flavor, texture, and appearance and made the greatest gain in weight. Fifty per cent glucose concentration caused severe shrivelling and failure to gain weight; these samples were of poor appearance, flavor, and texture. Twenty per cent glucose appeared to be the maximum to yield a satisfactory product. Hygroscopicity tests showed no practical difference in loss in weight between any of the samples at relative humidities below 70%. At very high humidities (94%) the glucose samples showed slightly less gain in weight. At R.H. below 45%, the 30 and 50% glucose content samples became very hard on 3 weeks exposure while the sucrose-invert fruit retained a desirable texture.

15

A COMPARISON OF SEVERAL METHODS OF HEAT STABILIZATION OF FLORIDA FROZEN ORANGE CONCENTRATE

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As part of a cooperative investigation on the heat stabilization of frozen concentrated orange juice, it seemed desirable to compare the various methods used for this purpose. Single strength orange juice extracted from Hamlin, Pineapple, Seedling, and Valencia fruit was heat stabilized in either a plate type heat exchanger, a small tube turbulent flow heat exchanger, or by direct steam injection at temperatures of 150° F., 160° F., 170° F. and 180° F. for five seconds. The heat-treated juice was concentrated in a falling film pilot plant evaporator to 55° Brix and was cut back to 42° Brix with unheated single strength juice. The results indicated that steam injection does a more efficient job of reducing the enzyme activity at 150° F. than does a plate type or small tube heat exchanger at that temperature. At 160°, 170°, or 180° F. little difference was noted between the amount of enzyme activity remaining and the type of exchanger used. The concentrate that was heat treated by steam injection for temperatures investigated remained stable for much longer periods when stored at 40° F. than did concentrate heat treated by either plate type or small tube turbulent flow heat exchanger.

16

SOME ASPECTS OF CANNING SOFT DRINKS

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The canning of soft drinks has created many problems necessitating considerable research and development work on the container, canning methods and product characteristics. Various factors adversely affecting shelf life of canned soft drinks are considered. Means for overcoming these problems are discussed.

17

FACTORS AFFECTING THE RATE OF CHICKEN MEAT DEHYDRATION UNDER VACUUM

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Chicken muscles of about 1½ in. by 2 in. were dehydrated in a vacuum plate drier. Factors studied included drier plate temperature, pressure, initial product temperature and moisture, sample thickness, precooking, and type of muscle. Final product quality was evaluated by means of rehydration ratios and organoleptic tests. Freeze drying was employed for comparison. Vacuum dehydration required one-fourth the drying time without apparent impairment of the product quality.

18

CHROMATE TREATMENT FOR PRESERVING EXTERIOR BRIGHTNESS OF PROCESSED FOOD CONTAINERS

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Experimentation under actual cannery operating conditions has shown that:

(1) Sodium chromate as an additive to either retort processing water or cooling canal water assists materially in preserving tin brightness and in lengthening rust-free shelf life of tinned food containers.

(2) Sodium chromate likewise minimizes the de-tinning tendency of alkaline waters.

(3) A simple dip treatment in sodium chromate solution, either before or after retort processing, is similarly effective.

(4) There is no detectable intake of the treating chemical into the cans.

19

THE EFFECT OF PROCESSING METHODS ON THE COLOR OF TOMATO JUICE

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The following processing methods for the manufacture of canned tomato juice were evaluated in terms of their effect on the color of the canned product: (1) hot-break high-temperature-short-time process; (2) cold-break high-temperature-short-time process; (3) hot-break conventional retort process; and (4) cold-break conventional retort process. Color data were interpreted in terms of Munsell hue, value and chroma renotations with Munsell hue and chroma renotations corrected for Munsell value as calculated from Hunter Color and Color-Difference Meter readings. Agreement with visual ratings in terms of official U. S. Department of Agriculture color scores, determined by matching specified Munsell disks, was also evaluated.

20

POTATO FLAKES—A NEW FORM OF DEHYDRATED MASHED POTATOES. II. SOME FACTORS INFLUENCING TEXTURE

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Improvements in the process for making dehydrated mashed potato flakes on double drum driers as related to the improvement of texture of the final product are described. The single stage drying process consists simply in preparing a mashed potato of good quality, applying the mash to the rolls of a standard double drum drier to produce a dry thin sheet and breaking and screening the sheet to obtain the size of flakes desired. The flakes, which may be as low as 2% moisture, rehydrate easily with liquid at temperatures from 50° F. to near boiling to yield a mashed potato of excellent color, flavor, and texture.

The effect on texture of the final reconstituted product of the flake thickness and the cooking time were described in the first paper of this series. This paper, second in the series, describes the effects of other important process variables including the solids content of the raw material, the dilution and other treatments of the starting mash, the drying temperature, the final moisture content, and the particle size of the final product.

21

PREPARATION AND STORAGE OF CANNED BERRY AND BERRY-APPLE PIE FILLINGS

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Improved quality berry and berry-apple pie fillings have been prepared from the following fruits: blackberry, black currant, blueberry, loganberry, raspberry, and strawberry. The fruit content of these fillings ranged from 70-85%. The percentage of apple sauce employed in the blends ranged from 35-40%. In the case of black currant fillings 60% apple sauce can be used without noticeably affecting color and flavor. Numerous stabilizing agents were used in these experiments. Those that proved satisfactory included selected modified corn and waxy maize type starches, tapioca (regular, —20 and —40 mesh), and locust bean gum. These were usually employed in a combination at a total concentration of 2 to 3%. However, black currant-apple fillings required only 0.2-0.6%. The process is premised on the use of as little water as possible and a heating period not exceeding 6 minutes. Thickeners are added near the end of the heating process. As the product is filled hot no sterilization is required. Fillings have been stored at 0°, 40°, 70°, 85°, and 100° F. Examination for quality and stability have been made at regular weekly intervals. No thickener breakdown has been observed at the higher temperatures. Color and flavor of strawberry and raspberry fillings soon become unsatisfactory at elevated temperatures.

22

CANDIED FRUIT METALLIC DISCOLORATION

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Artifically colored candied fruits are shown to be discolored by metallic ions of copper, aluminum, iron, and tin. These ions are absorbed by the fruit tissue from the surrounding syrup and the metal ion concentration of the syrup is consequently reduced. Metallic discoloration of candied cherries is shown to take place as a result of two independent reactions. The first is a reaction of the ions with the natural fruit pigments, especially tannins, whereas the second appears to be a stoichiometric reaction between the ions and the permitted artificial food dyes. Addition of 0.2% calcium phytate reduces discoloration by copper concentrations up to 50 p.p.m. while 0.025% eliminates undesirable reactions of 100 p.p.m. aluminum. Disodium ethylenediamine tetraacetate was ineffective in preventing discoloration by copper or aluminum.

23

THE EFFECT OF COPPER UPON THE DEVELOPMENT OF COLOR IN THE PROCESSING AND STORAGE OF HONEY

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Samples of dark and light floral honeys were treated in the presence and absence of copper metal, at different temperatures, and for varying lengths of time. In the cases investigated, samples exposed to copper contamination contained a higher level of copper than their respective controls without copper treatment. This difference was not reflected in per cent transmission during storage at 50° C.

Initial differences in per cent transmission could be influenced by times and temperatures of processing. However, these differences decreased rapidly during storage. It is of interest to note that samples of both dark and light honeys which received no treatment of any kind and ranked with the lowest in copper content, showed per cent transmission values after about 3 weeks incubation at 50° C. along the same order as those samples most heavily contaminated with copper.

24

IMPORTANT NEWLY DEVELOPED FLAVORING AROMATICS

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Newly developed aromatics for use in the flavoring and general food industries are described and the production and employment of old-time esters, ethers, etc. as compared with the newly-developed products, are described. Available information on important aromatics, identities of true chemicals by their true nomenclature, and chemical and physical data are given.

Other sections of the paper treat of the importance of methyl beta methyl thiolpropionate and alpha furfuryl mercaptan as natural constituents of pineapple and coffee flavors; the production of furfuryl compounds and their usability as flavoring components; the development of polyfunctional ketones and their use in the flavoring industry; and the development and production of diallyl sulphide as a constituent of garlic and onion essential oils.

Simulated chemical products are described and the necessity of correct chemical identity is pointed out. Finally, historical data on the production of aromatics for use in food products, bringing such information up to date, are given. The paper will be accompanied by a list of newly developed aromatics, showing their chemical and physical properties and suggested usage.

25

OBSERVATIONS ON BLACK PEPPER

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Black pepper has been traditionally used as a seasoning in food for its contribution to aroma and "bite." Not all of the components of black pepper which contribute to bite have been fully characterized. There is general agreement that the compound piperine and its isomer chavicine play a major role in imparting "bite" to pepper. This paper presents results of work done with these compounds.

26

THE EFFECT OF WATER IMPURITIES ON THE FLAVOR OF BREWED COFFEE

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Normal potable waters contain a variety of dissolved ions and organic molecules. The object of this study was to determine whether any of these ions or molecules in the concentrations usually present in waters would have a detectable influence on the flavor of brewed coffee. Taste threshold concentrations for a number of common impurities have been measured. In general, the threshold concentrations of inorganic ions are greater than the concentrations normal to potable waters. They have no influence on the flavor of brewed coffee. In some instances organic impurities may decrease the acceptability of brewed coffee.

27

ORGANIC ACIDS IN BREWED COFFEE

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The organic acids in freshly brewed coffee and in serial extractions of the same ground coffee have been determined by chromatography on silica gel. There appear to be some changes in the relative amounts extracted as extraction continues. Changes in the organic acids have been noted in brewed coffee which may have some relation to the staling of brewed coffee.

28

VOLATILE REDUCING SUBSTANCES (VRS) AND VOLATILE NITROGEN COMPOUNDS IN CANNED FISH

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The content of VRS total volatile nitrogen (TVN) and of trimethylamine nitrogen (TMN) has been determined in canned California sardines (pilchards), Pacific and jack mackerel, California anchovies, herring, and tuna. These have been correlated with the state of freshness of the samples as judged organoleptically. No definite correlation between the TVN and TMN contents in any of the canned fish samples and the organoleptic judgments has been observed. In contrast, the VRS content was found to be a reliable indicator of the condition of the canned fish. A relationship has been observed between certain species of fish and their TMN contents, irrespective of their state of freshness.

29

UTILIZATION OF FRUITS IN PROCESSED FOOD PRODUCTS

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(Babcock-Hart Award paper)

While much of the research of this department has dealt with roles of microorganisms, pH, enzymes and other factors in the deterioration of and in the processing of fruit and vegetable products, and might be a suitable topic for this paper, it was thought that a brief review of our investigations on including fruits in various more or less staple food products such as candy, breakfast cereals, bakery products, frozen desserts and others would be more appropriate because of the special nutritive values of fruits. Their inclusion in certain staple food products improves the dietary value. Technical and scientific problems often arise in preparing, packaging and storing such combinations and must be solved before commercial production can be undertaken. Action of oxidizing enzymes, nonenzymic oxidation, use of pectic enzymes, troublesome color changes and undesirable crystallization of sugars or tartrates are examples of such problems. These and other problems as well as a discussion of formulations, technological problems and production procedures will be covered. Attention will be called to some of the dietary values of fruit when included in such products.

30

MORE MILES PER POUND OF FOOD

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If enough food can be carried aboard a patrol ship to double its time in the combat zone, it means that one ship can do the work of two. This is being accomplished by reducing the amount of food waste and increasing ration density. Use of prefabricated waste-free meats, precooked frozen or canned meats, dehydrated fruits, juices, eggs, and vegetables, ready-prepared foods, rindless cheese, frozen fruits, vegetables, and eggs, concentrated juices and coffee, together with food preparation techniques that give the greatest number of servings per pound of food and less unconsumed food reduce waste. Ration density can be increased by using the above noted foods, storage shelf adjustments, and can sizes which are compatible, square containers where possible, and by compressing foods which have much included air.

31

NUTRITION EDUCATION—OPPORTUNITY AND RESPONSIBILITY

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Scientists have made good progress toward better understanding of the relationships existing between food and health. Unfortunately, progress in the educational processes of translating and applying our present knowledge in nutrition to our food habits and food use has not been at all comparable.

Public education in nutrition as yet has not been sufficiently extensive to enable the consumer to distinguish between reliable and unreliable information. This situation creates an almost unlimited opportunity for contributing to improved quality of life in the United States through a program of education aimed to improve our eating habits.

The public and the food industry have much to gain from a broader understanding and more extensive application of the findings arising from nutrition research. Food technologists will recognize the opportunity to make an important contribution toward providing the leadership and guidance needed to assist those who are capable of carrying on effective nutrition education activities.

The need for a greatly increased program of education in nutrition is evident. The fact that a majority of our people look to the professional groups for information upon which they can rely furnishes one of the best possible reasons for professional scientists to assume more public responsibility and use all available ways and means for dissemination of sound nutrition information.

More active participation by food technologists and other scientists in nutrition education programs is needed to assist in making available to all a true interpretation of the findings of nutrition research.

32

THE PROGRAM OF THE VITAMIN COMMISSION OF THE INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

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The International Vitamin Commission was established by the Food Division of the Applied Chemistry Section, International Union of Pure and Applied Chemistry, to attempt to bring about agreement on assay procedures employed in the evaluation of food or feed materials traded internationally on the basis of their vitamin content. Among such products are marine liver oils and concentrates, irradiated sterols, carotenes, dried yeast, etc.

Many such procedures have been investigated or adopted intranationally, particularly those concerned with pharmaceutical items. The object of the Commission is to recommend for international use the best features of these methods keeping in mind local factors which may affect their suitability. The aim is for the highest specificity compatible with reproducibility and convenience.

At the first meeting of the Commission in London in December, 1954, substantial progress was made toward agreement on a vitamin A assay. International collaborative studies were decided upon as a means of resolving certain questions, *e.g.*, the interchangeability of isopropanol and ethanol as solvent vehicles for spectrophotometric measurement of unsaponifiable extracts. It is proposed that vitamin A oils be considered in two categories depending upon their initial spectral purity, only the crude oils requiring chromatographic purification prior to spectrophotometry.

The next meeting of the Commission is scheduled to be held at Zurich in July, 1955, in connection with the meeting of the I.U.P.A.C.

33

DIGESTION AND ABSORPTION OF FAT

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Only within the past decade has an understanding of the mechanisms by which dietary fat is digested and absorbed been approached. Present knowledge indicates that there is little hydrolysis of fat in the stomach. After entering the intestinal tract pancreatic juice and bile are intimately mixed with the fat. An enzyme, lipase, which is present in the pancreatic juice, hydrolyzes the fat. This hydrolysis has been shown to be a series of directed step-wise reactions from triglyceride to 1,2-diglyceride to 2-monoglyceride. It has not been determined whether there is further hydrolysis of the monoglyceride.

In connection with the mechanism of absorption, there are experiments which indicate that absorption of complete and partial glycerides takes place. However, none of these studies establish this point unequivocally. Thus, it is still necessary to determine whether the species absorbed is complete or partial glycerides or free fatty acids. It is certain that fat having passed through the intestinal wall into the lymph is present as triglyceride. Such passage is not a passive transfer but probably involves synthesis and hydrolysis of triglycerides, rearrangement of triglycerides, alterations of the fatty acids that have been absorbed, and perhaps intermixing of endogenous fatty acids with the dietary fatty acids.

34

PREPARATION OF DEHYDRATED PORK OF REDUCED GLUCOSE CONTENT

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The storage life of dehydrated pork was extended by reducing the glucose content. Yeast cells (*Saccharomyces cerevisiae*) and glucose-oxidase enzyme were used in laboratory trials at the Missouri Station. Meat particles of ⅛-inch grind were used. Fermenting the meat with 5 to 10% yeast, yielded a desirable product. The optimum reaction period was found to be 4 to 8 hours at 40° F. The shelf life of dehydrated pork was further improved when the meat was cooked prior to the fermentation.

Food grade hydrogen peroxide was used with the liquid glucose-oxidate enzyme to furnish an adequate supply of oxygen. Four parts of the enzyme and 5 parts of peroxide were used with each 1000 parts of meat. The optimum reaction time was 4 hours at 50° C. Nearly 25% more glucose was converted to gluconic acid when glucose-oxidase was reacted with cooked meat rather than that which was uncooked. The taste panel found the enzyme treated meat superior to that which was untreated.

35

THE EFFECT OF UNIT PROCESSES ON THE SALT AND MOISTURE CONTENT OF HAMS PROCESSED COUNTRY-STYLE

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A study was made of the influence of unit operations—curing, soaking, drying, smoking, and aging—on the salt and moisture contents of hams processed country-style.

Relatively low salt concentrations of less than 1% found on the interior of the hams after the curing process indicate the vulnerability of the hams to anaerobic spoilage. The progress of the salt into the hams and the concurrent moisture losses are shown in appropriate tables and charts.

Sixteen paired hams were given a conventional dry cure. The curing mixture was applied at the rate of 1¼ ounces per pound of meat, and all hams were held in a refrigerated room at 38° F. for 40 days. All hams were soaked in water and then dried—half with natural convection and half with forced convection. The hams were then soaked—half receiving a long cool smoke and half receiving a short one-day smoke at 125° F. All hams were wrapped and aged at prevailing room temperatures.

Salt and moisture analyses were made on plugs of meat taken at the completion of each unit operation. The plugs were sliced

longitudinally for duplicate samples, and in three sections transversely for the determination of salt and moisture concentrations at various levels.

36

THE EFFECTS ON COLLAGEN AND PALATABILITY OF DIFFERENT METHODS OF COOKING BEEF ROUND OF COMMERCIAL AND PRIME GRADES

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Fourteen cooking methods were compared with a standard braising method using beef round of *commercial* and *prime* grades, and top and bottom muscles. The collagen content of meat, and moisture, fat, pH, total nitrogen and free amino nitrogen of meat and drippings were determined. The effects of the cooking methods on palatability and shear values were studied.

The collagen content of cooked beef was significantly higher for *commercial* than for *prime* grade, but was not significantly different for the top and bottom muscles of the round. The average collagen loss on cooking by all methods was 61%. Losses of collagen on cooking increased as the internal temperature of the meat increased, and were greater when the meat was cooked at 10 to 15 p.s.i.g. than at 5 p.s.i.g. or by the standard method. Collagen losses were higher in meat roasted at 250° F. than at 300° F. or braised by the standard method, and were especially high in meat soaked in vinegar. Collagen losses in meat braised without added water were lower than for any other method. Treatment of the meat before cooking by pounding, scoring, or the use of enzymes had little effect on the loss of collagen. It was found that the more soluble nitrogenous constituents went into the drippings, but that the total amount of free amino nitrogen did not increase during cooking.

The palatability scores and shear values indicate that the time-honored braising method may be recommended for cooking beef round. If desired, the meat may be pounded or treated with papain before braising to increase tenderness. Roasting at 250° F. is a superior method for cooking beef round except for the dry appearance of the surface. Palatability scores were on the whole higher and shear values lower for beef of *prime* than of *commercial* grade. Little difference was noted in the reaction of beef of the two grades to the cooking methods used.

37

USE OF DE-HULLED EXTRACTED SOYBEAN FLAKES AS A GROUND MEAT EXTENDER

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The flavor of defatted soybean flakes has restricted its use as an important protein food in this country. A number of preliminary experiments based on literature and patent references were performed to find a treatment which would reduce the undesirable flavor. The most practical method was to treat wetted flakes in live steam for a short period. Flakes thus prepared were mixed in various ratios with ground beef. Resulting samples were grilled and presented to a taste panel. The organoleptic scores were statistically analyzed. All members preferred the meat containing treated soybean flakes to the all-meat control. The optimum content of flakes was found to be 25% of the mixture.

38

VEGETABLE FAT WHIPS FOR BAKERY AND HOUSEHOLD USE

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These products are differentiated from one another in terms of ingredients and in terms of function. Criteria for selecting ingredients are suggested. Manufacturing processes and methods for quality control are discussed. Storage problems are noted, and procedures suggested for preventing undesirable changes in the whip emulsion after preparation and during storage.

39

STUDIES RELATED TO THE MANUFACTURE OF FILLED MILK CHEESE *

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A satisfactory filled milk for cheese making was obtained by homogenizing the warm liquid ingredients (natural skim milk or reconstituted skim milk and vegetable oil) before and after pasteurization at 500 p.s.i. Cheese of the cheddar type made from above mentioned filled milk exhibited satisfactory fat incorporation and retention. Similar satisfactory body and texture were obtained in cheese made from natural milk and from filled milk containing natural skim milk, but less satisfactory from filled milk containing reconstituted skim milk. All of the filled milk cheese differed considerably in flavor from that of natural cheese after 3 to 6 months of ripening.

Comparison trials involving four different vegetable fats used in the manufacture of filled milk cheese did not show a clear-cut superiority of any of the 3 months' old cheese.

* Commercial Grant Project—Mrs. Tucker's Foods, Inc.

40

ARMY PREVENTS INFESTATION OF CELLOPHANE WRAPPED RATIONS

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The Quartermaster Subsistence Testing Laboratory has determined how weevils were able to infest stored cereal ration bars that had been packed without contamination. The problem became perplexing when experiments showed that weevils could not bore through the cellophane in which the bars were wrapped. Eventually, it was discovered that adult beetles could slip under the folds of the wrapper, lay their eggs, and depart. The climax was the finding that the newly developed larvae, and not the beetles, had the capacity to get *through* the wrapper by boring from within. The observations made, methods used, and controls proposed are given.

41

PROTECTIVE PACKAGING OF FOODS AGAINST MOISTURE CONDENSATION

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As refrigerated storage of foods becomes more general, it is increasingly important to understand and control moisture condensation. Rusting of tin cans, sugar blooming of chocolate candies, molding of nuts and dried fruits, and weakening of fiberboard containers are among the consequences of moisture condensation. High humidity and fluctuating (night versus mid-day) temperatures in common storage warehouses frequently result in considerable moisture condensation.

Moisture vapor tends to travel from a warm to colder surface and condense upon reaching the dewpoint. Condensation may occur on the inside of moistureproof packages of food as temperatures drop, causing droplets of moisture on refrigerated products or "cavity ice" inside packages of frozen food.

As temperatures rise condensation may occur on the outside of packages and, (a) run off if the surface is moistureproof; (b) penetrate and weaken the package, and possibly injure the product; (c) penetrate the package and be intercepted by an absorbent or desiccant without injury to the product; or (d) evaporate if the relative humidity is low. Correction of the first three of these conditions comes under protective packaging, and the last under controlled environment.

Temperature and relative humidity gradients were taken in cases of representative foods, including canned salmon, sweet potatoes, and turnip greens; jars of grape preserves, chocolate candies, and military rations; when transferred from 70° F. and 50% relative humidity, to 32° or 0°, and returned to 70° F. Based on these data, condensation-proof packages for certain types of products were designed.

42

FACTORS THAT MAKE PACKAGES TALK

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The importance of scientific considerations in regard to measurable consumer appeal of the package is pointed out.

With the modern techniques of merchandising, particularly on a self-service basis, the need for complete package design which will appeal to the consumer hinges on values which formerly have been unmeasurable. Tests of behaviorisms have been brought out as a measurable device which can be used in modern packaging. These values have previously fallen in the category of psychological reactions which consumers find difficult to put into words.

Specific examples will be illustrated as to the factors involved for predetermining the elements necessary for good package appeal. Also, specific cases and results will be outlined.

43

TECHNICALITIES IN UTILIZATION OF LIMP AND THIN FILMS ON AUTOMATIC PACKAGING EQUIPMENT

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A description will be given of the problems involved in feeding, folding, and heat sealing limp films. Solutions to these problems by means of conveyor, folder, and heat seal platen design will be discussed. Design description and adaptation of special machinery for handling limp films such as stretch-wrap and rubber bale wrapper will be presented.

44

USE OF HIGH-VOLTAGE CATHODE RAYS TO DESTROY BACTERIA OF THE SALMONELLA GROUP IN POWDERED, LIQUID, AND FROZEN EGG WHITES*

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The doses of high-voltage cathode rays required for elimination of *Salmonella* in powdered, liquid, and frozen egg whites have been determined. Evidence has been found that various atmospheres did not appreciably affect these dose requirements. An investigation has also been made of the effect of high-voltage cathode rays on the organoleptic and functional qualities of egg white products.

* A report of research done under contract with the U. S. Department of Agriculture and authorized by the Research and Marketing Act of 1946. The contract is being supervised by the Western Utilization Research Branch of the Agricultural Research Service.

45

CATHODE RAY IRRADIATION OF CHICKEN MEAT FOR THE EXTENSION OF SHELF LIFE

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High-voltage cathode rays have been used to destroy typical bacteria in chicken meat for purposes of holding the product at refrigerator temperatures above freezing. Chicken meat has also been sterilized with high-voltage cathode rays and held at room temperautres. The effects of treatment with high-voltage cathode rays on bacterial content, organoleptic acceptability, and stability of lipoid components were investigated.

46

STUDIES ON THE SENSITIVITY OF FOOD SPOILAGE MICROORGANISMS TO VARIOUS ANTIBIOTICS

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Spoilage organisms from twenty protein foods were tested against a variety of well-known antibiotics including chlortetracycline, oxytetracycline, streptomycin, neomycin, and polymyxin B. The foods were allowed to spoil under refrigerated conditions for 1 to 3 weeks. Suspensions of the organisms were lyophilized and plated into nutrient agar containing different concentrations of the various antibiotics. Following incubation, the viable bacteria were counted by standard techniques and the sensitivity of the organisms to the antibiotics was determined.

The results indicate that chlortetracycline was more effective than any of the other antibiotics studied. Typical results with hamburger spoilage organisms plated into medium containing 1 p.p.m. of the test antibiotic were as follows: control, 158,000; chlortetracycline, 1000; oxytetracycline, 8000; polymyxin B, 48,000; streptomycin, 83,000; and neomycin, 140,000 bacteria per mg. of lyophilized suspension.

Although the above *in vitro* technique has certain limitations in evaluating antibiotics for food preservation, the results have been successfully applied to the preservation of several of the above protein foods with satisfactory correlation.

47

OBSERVATIONS ON ANTIBIOTICS IN A MARKET MILK SUPPLY AND THE EFFECT OF CERTAIN ANTIBIOTICS ON THE KEEPING QUALITY OF MILK*

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The incidence of detectable concentrations of antibiotics in milk from cows treated for udder infections has aroused great interest among dairy technologists and animal nutritionists. In this connection, investigations were conducted to determine the prevalence of antibiotics in market milk supplies in the Columbus area.

A systematic procedure reported by Henningson *et al.* was used to detect the presence of critical amounts of antibiotics and/or inhibitory substances in milk. The procedure included the use of the Disk Assay Method performed by soaking a paper disk with the test sample and placing it on a hardened agar layer seeded with antibiotic sensitive organisms. Any sample forming a clear zone of inhibition around the disk was suspected to contain antibiotics. The test was further confirmed by performing simultaneously a starter inhibition test. Samples developing a clear zone of inhibition and producing less than 60% of acidity as compared to a control (known to be free of antibiotics) were considered positive. Samples developing only the zone of inhibition or less than 60% of acidity were considered questionable. Samples which exhibited no inhibitions were considered to be free from antibiotics.

In a study in progress, raw and pasteurized milk samples were collected from various commercial dairy plants. The results to date indicate that only about 2% of the samples were found to contain high enough concentrations of antibiotics to be detected by the above procedure, and only about 8-10% of the samples were found to be "questionable." Hence, the problem of prevalence of critical concentrations of antibiotics in the milk supplies around the Columbus area is not widespread.

Studies have been conducted to determine the effect of various antibiotics upon the keeping quality of milk as determined by physical characteristics and organoleptic examination. It has been observed that raw milk inoculated with 0.5 to 1.0 p.p.m. of penicillin, streptomycin, aureomycin and terramycin spoiled within 7-10 days when stored in a refrigerator at 2-4° C. However, in pasteurized milk (143° F. for 30 min.) peni-

* This study was supported by a grant from the U. S. Public Health Service (National Institutes of Health) and by funds from the Ohio Dairy Products Research Fund.

cillin and streptomycin prolonged the keeping quality by about 1-2 weeks, and aureomycin and terramycin by about 4 weeks with the only defect being a slight storage flavor which was invariably observed in almost all the samples after 1-2 weeks of storage.

48

CHARACTERISTICS OF INSECT INFESTATION IN NATURAL CONDITION RAISINS

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As part of a program to prevent stocks of insect infested raisins from being received at the packing plants, a comprehensive study was made of infestation in raisins which had been held in non-fumigable storage. Results show that the time in unprotected storage and the area of production are important variables in the population levels of stored products insects. The latter variable is also important in *Drosophila* populations of the raisins.

Succession in types of storage insects was followed.

49

SURVEY OF CHEMICALS USED IN FOOD PROCESSING

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The more important chemical additives used in food processing are reviewed according to the following classes of foods: baked goods; meat and dairy products; fruits and vegetables; and beverages and confections.

Special emphasis is placed on their safety and the technological benefits rerulting from the use of chemical additives in foods.

50

FLAVOMATICS IN FOOD

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"Flavomatics," defined as synthetic aromatic organic chemicals listed for use in flavor formulations, will be placed in their historical setting. Their aesthetic, practical, and economic needs in food will be discussed. Ramifications relating to safe use tolerances in their complex and varied end uses will be described. Attention will be given to certain unique factors such as self-limitation by taste.

51

LEGISLATIVE CONTROL OF PESTICIDAL CHEMICALS

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The effect of legislation on the production, distribution and use of pesticides, with particular reference to the effects of the Miller Pesticide Amendment to the Food, Drug, and Cosmetic Act with the regulations thereunder, will be analyzed.

52

CHEMICAL ADDITIVES AND THE FEDERAL FOOD, DRUG, AND COSMETIC ACT

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Current problems of mutual interest to the food technologists of the United States and the Federal Food and Drug Administration are treated. The effect of the recent Miller amendment to the Food, Drug, and Cosmetic Act, which regulates pesticides for use on raw agricultural commodities, will be discussed. Current problems involving the addition of chemicals to foodstuffs and studies of the Food and Drug Administration by an eminent Citizens' Advisory Committee, appointed by the Secretary of Health, Education, and Welfare, are further topics to be presented.

53

THE DIRECT MICROSCOPIC ENUMERATION OF BACTERIA IN THE WASHINGS OF GREEN BEANS

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The epiphytic flora of green beans do not stain well with most procedures employed in bacteriology. They do stain well with Hucker's crystal violet stain, if care is taken in the preparation and the washing of the slide. Use of the stain results in much greater total count, because the very small cells stain and are recognizable. The counts of replicate preparations are reproducible, with a coefficient of variation of 9.1 or less.

The numbers of bacteria vary with irrigation, and range from several to 60 millions per gram of raw bean. Reduction during processing for freezing ranges between 24.7 and 53.7%. The decrease is not consistent with any factors observed, nor is it constant with any morphological group. Because of the relatively high degree of retention of bacteria on the bean during processing, the direct microscopic enumeration of the bacteria on the finished product is valueless in determining improper practice in the handling and processing of green beans.

54

SPECIES OF CLOSTRIDIUM ASSOCIATED WITH "ZAPATERA," A MALODOROUS FERMENTATION OF OLIVES

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"Zapatera," a malodorous spoilage found in all types of brined olives commonly imported into the United States or produced in California, is characterized by a loss of titratable acidity and an accompanying increase in the pH of affected brines. Volatile compounds develop and give rise to off-odors which vary from mild "cheesy" ones to foul, fecal stenches. Lactate-acetate fermenting cultures of *Clostridium* have been isolated and identified. *C. bifermentans*, the most predominant species, was isolated from every sample. Other less abundant species included *C. sporogenes* and various members of the *C. butyricum* complex. Control of the spoilage is effected by stabilization of brines at 8% salt and direction of the fermentation until the pH is 3.8 or less.

55

CHANGES IN THE YEAST FLORA OF OLIVE BRINES

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The yeast flora occurring in the brine of green olives during storage in vats and barrels were investigated and 171 yeast isolates were identified. Three stages in floral change were noted:

1. An initial miscellaneous, non-characteristic flora.
2. An intermediate stage in which species of *Candida* predominated.
3. A final stage in which nearly all isolates were *Pichia membranaefaciens*.

Relationships of tolerance to salt, pH, and temperature as well as ability of the various groups to utilize lactic and acetic acid were studied.

56

THERMAL RESISTANCE DETERMINATIONS IN STEAM USING THERMAL DEATH TIME RETORTS

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The construction, operation and use of thermal death time retorts for the determination of the thermal resistance of bacterial spores and the adaptation of this equipment for the cotton plugged tube procedure are discussed. Closure of thermal death time cans with undercover gassing as an alternative to vacuum closure is described. Satisfactory operation of this system with either thermal death time cans or plugged tubes at temperatures as high as 270° F. is demonstrated. Typical data illustrating the various uses of this equipment are presented and analyzed.

57

HEAT ACTIVATION OF BACTERIAL SPORES

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Studies with vegetative cell free bacterial spore suspensions show that there is a time-temperature relationship for heat activation of suspensions. The activity appears to be a first order reaction. A comparison of the rates of activation by heat and the rates of destruction by heat suggest that some relationship may exist between thermal activation of spores and the thermal destruction of spores.

Heat activated spores lost their stimulation when stored, and could be reactivated with a subsequent heat treatment. Evidence indicates that the heat activation of spores is related to the stimulation of some intrinsic factor rather than to the destruction of a toxic one.

58

ACTIVATORS AND INHIBITORS OF SPORE GERMINATION

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Results of this investigation indicate that bacterial spores are complete entities within themselves. They contain all essential materials required for germination (as defined by a loss of heat resistance) except sources of energy. Glucose solutions and all intermediate metabolites of glucose studied were capable of serving as suitable substrates for germination. Evidence indicates that the metabolism of spores is closely related to the metabolism of the vegetable cells. Spores have little or no reserve supply of energy and obtain it by the oxidation of carbon compounds which produce energy rich phosphate bonds.

The influence of respiratory inhibitors on the utilization of glucose, and intermediates is discussed. Quantitative studies relating to sites of inhibition and the energy yielding reactions are presented.

59

INTERACTIONS BETWEEN ASCORBIC ACID AND PSYCHROPHILIC BACTERIA ASSOCIATED WITH THE DISCOLORATION OF PREPACKAGED BEEF

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Certain psychrophilic organisms are known to cause rapid discoloration of prepackaged meat. Conversely, ascorbic acid has been shown to delay discoloration of fresh prepackaged meat. Laboratory experiments showed that 2 strains of *Pseudomonas* sp. were inhibited greatly by 0.1% ascorbic acid in nutrient broth. This was true at both room and refrigeration temperatures. These same strains of *Pseudomonas* sp. protected the ascorbic acid *per se* from oxidation at room temperature, but had no significant effect on the concentration of total vitamin C-like compounds at either temperature of incubation. No effect of ascorbic acid on the growth of psychrophilic bacteria on the surface of prepackaged beef was noted in the preliminary experiments. However, ascorbic acid was shown to delay discoloration of both inoculated and uninoculated steaks held at refrigeration temperatures.

60

SORBIC ACID AS A FUNGISTATIC AGENT AT DIFFERENT pH LEVELS FOR MOLDS ISOLATED FROM STRAWBERRIES AND TOMATOES

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Various fungi isolated from tomato and strawberry fruits were placed in a glucose peptone medium with concentrations of sorbic acid ranging from 0.01% to 0.10% at pH 3, 5, and 7. These same fungi were also seeded in strawberry puree at a pH of 3.3 and 4.0 with concentrations of sorbic acid of 0.025%, 0.050% and 0.075%. Some strains of *Penicillium* and *Aspergillus* grew at a pH of 3.3 in 0.050% sorbic acid.

When tomato juice was used as the medium, all fungi except one strain of *Aspergillus* were inhibited at a pH of 4.4 in 0.050% sorbic acid. When 0.075% sorbic acid was added to the various media, no growth of the fungi occurred.

61

THE PEEBLES INSTANT MILK PROCESS

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The Peebles Process produces quickly soluble, free-flowing, non-foaming, non-fat dry milk with the flavor of fresh milk. The process uses conventional low heat, spray dried, extra grade, nonfat dry milk solids as its raw material. This powder is purchased from various sources and after careful laboratory analysis, various batches of powder are blended in a ribbon mixer which delivers the powder through a metering device to an air conveyor which discharges into the processing chamber.

In the processing chamber the moisture is adjusted under carefully controlled conditions of time, temperature and moisture, and a fluffy, sponge-like material is produced and delivered to a belt conveyor which, after a suitable period, discharges into shaker dryers of special design where the moisture content is reduced to 3% to 3½%.

During the latter stages of the Process, the product takes on granular characteristics and a sufficient quantity of milk sugar is converted to the monohydrate to make the product non-hygroscopic. The dry powder from the shaker dryers goes through sizzling rolls to drums where the final product is stored prior to packaging in consumer packages.

The product is subject to continual control testing for solubility index, flavor, moisture and density.

62

ENGINEERING APPROACH TO FOOD PROCESSING PROBLEMS

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There can be only two basic types of engineering problems, one being to work out a solution to a problem that has not been solved before or possibly has not existed before, and the other to modify, correct, or improve something that has been previously used. In the case where the problem is to improve or change an existing method, the first step is to go through a process of brain washing in order to completely forget and utterly disregard the

existing method or process. This is the most difficult step but is absolutely essential in reaching the best engineering solution.

The next two steps are common to both types of problems, the solution to an existing problem or working out the answer to a new problem. The second step consists of accurately and concisely writing down the step-by-step requirements of the problem, disregarding everything else except stating the desired result step by step from start to finish.

The third and last step consists of applying the simplest and most straightforward engineering answer to each of the step-by-step sequences outlined in the list of requirements. After completing the step-by-step engineering solutions, the project should be reviewed in order to consolidate steps wherever possible and to streamline the overall engineering design. This basic procedure may appear to be both simple and obvious, but it is surprising to know how few engineers actually put this formula into practice and it is equally surprising to know how well the formula works when intelligently and diligently applied.

63

OPERATIONS RESEARCH—APPLICATIONS IN FOOD TECHNOLOGY

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Probably the outstanding "new" management approach in industry is "O.R." or Operations Research. Well over 600 problems, mostly in production, inventory control and marketing, have been solved and the number of corporations and research groups using the methods is rapidly increasing. The types of problems and the results which are possible are analyzed. Specific applications will be listed in the field of the food technologist. Many of the really tough problems of the food industry appear amenable to solution with this new approach which has reached the stage of practical application and efficient use. The possibility of improved understanding of operations and decision problems appears particularly promising.

64

EXPERIMENTAL PRODUCTION OF TOMATO POWDER BY SPRAY DRYING

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A pilot-plant spray drier, 8.3 feet in diameter, was modified to provide conditions necessary for drying excessively "sticky" materials such as tomato pulp. Production of satisfactory tomato powder in the pilot-scale operations was found to require avoidance of air spin in the drying section of the unit, provisions for the introduction of cool air into the lower portion of the drying chamber, and means for transferring the powder from the humid air of the primary cyclone to air of low humidity for collection in a secondary cyclone. Experimental procedures, operating conditions, and results are outlined. It was found that tomato powder of good quality can be prepared from hot-break paste with added antioxidant. Full evaluation of this new method will require trial production tests in suitably designed, commercial-scale equipment, and studies to determine the storage stability of the product.

65

ENGINEERING AIR REMOVAL FROM NON-PROCESSED FOODS IN METAL CANS

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In the successful packaging of a wide variety of non-processed food products in metal containers, certain critical levels of low air content are necessary. This requires in many instances specific procedures for specific products. Vacuum packing and gas packing of dry products as well as undercover gassing and jetting of liquid products—as applied to meet specific packaging specifications—are discussed.

66

A FLOW METER FOR THE FOOD INDUSTRY

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Some of the means of measuring flow which have been available to the Food Industry in the past are reviewed. A Flow Meter, which is entirely new in principle and completely sanitary in design, is described. The way in which this meter measures flow and one or more applications in which it has been sucessfully used in the Food Industry are presented.

67

FLEXIBLE AUTOMATIC RETORT CONTROL SYSTEM

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Many plants are finding that increased flexibility of retorts are required. A completely automatic retort control system has been developed permitting steam and water cooks to be accomplished in the same retort by merely turning a switch.

Steam cooks provide time and temperature venting, timed sterilization and time and temperature cooling. The water cook cycle gives preheat, timed sterilization, and time and temperature cooling.

Visual indication of position in any part of cycle is readily viewed by the operator.

This development provides a control system which is simple to install, has greater dependability, and reduced maintenance than any system previously available.

68

EFFECT OF CELLULOSIC MATERIALS ON THE CONSISTENCY OF TOMATO JUICE

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Although a tomato is composed largely of water, structurally it is a solid. If its structure is destroyed by maceration, the same structural elements that once maintained the tomato in the solid state are present also in the resulting liquid. It might be expected that these structural elements would have some effect on the properties of the liquid.

A tomato can be dissected into regions differing greatly in structure. Juices made from these regions did in fact vary in accordance with the structural elements they contained. The principal structures visible microscopically in the thickest juice (made from the outer tissues of a tomato) were cell walls and small granules. The thinnest juice (made from the liquid of the seed cavities) contained numerous granules but no cell walls. Homogenization of the juices resulted in a pronounced increase in consistency of the thick juice, but caused almost no change in consistency of the thin juice. These observations and others indicate that the cell walls present in tomato juice make a major contribution to consistency. Of minor consequence are the small granules and the soluble solids fraction of the juice.

Although cellulose is the principal constituent of the cell walls in tomato juice, pectic compounds also may be present in varying amounts. If both cellulose and pectic compounds are present, maximum consistencies occur. Removal of pectic compounds invariably lowers consistency, whereas enzymatic removal of cellulose destroys consistency almost completely.

69

A COMPARISON OF THE STABILITY OF CANNED CONCENTRATED TOMATO JUICE AND CANNED SINGLE-STRENGTH TOMATO JUICE

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A four-fold concentrate of tomato juice was compared with single strength tomato juice during storage at 40°, 72°, and 100° F. for a period of 2 years. Deterioration of the concentrate, as evidenced by development of off-flavor, loss of ascorbic acid, and changes in color, occurred more rapidly than in the single strength juice. Internal container corrosion, accompanied by loss of vacuum and subsequent development of swelled cans also occurred at a more rapid rate in the concentrated product. At 6 months, approximately 4% of the cans of concentrate, stored at 100° F., had developed into flippers, springers, and swells. After 15 months, more than 75% of the concentrate cans at 100° F. were in this condition. No swelled cans appeared in the single-strength juice during 2 years' storage at all 3 temperatures, and in the concentrate at 40° F. and 72° F. The effect of temperature on vitamin C content is also shown.

70

STABILITY OF DEHYDRATED POTATO PRODUCTS

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This investigation was concerned with storage stability of dehydrated potato dice and granules (dried mashed potatoes) processed under different conditions. Sulfite was applied to dice by 3 methods that have been used commercially: a light spray of concentrated sulfite-bisulfite solution (after blanching, before drying); a heavy spray of dilute sulfite solution; and absorption of sulfur dioxide from combustion gases during direct-fired tunnel drying. Protection against nonenzymatic browning at 7% moisture and 100° F. (38° C.) was somewhat greater with dilute sulfite spray than with the other 2 methods of sulfite application. Reduction of moisture from 7 to 4% effectively retarded browning. In granules browning was effectively retarded by moisture reduction from 7 to 4%, but relatively little protection resulted from increasing sulfite content from 110 to 400 p.p.m. Rancid odor and absorption of oxygen were reduced by treatment of granules after drying with butylated hydroxyanisole. Protection against rancid flavor in reconstituted product was less than against rancid odor in dry granules. The results suggest, however, that antioxidants could be used in potato granule manufacture to help control rancidity.

71

OBSERVATIONS ON PRE-PEELING OF POTATOES

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Laboratory experiments and observations of commercial operations have helped to elucidate several factors in the peeling of potatoes for marketing as peeled and otherwise prepared products. (a) Low-temperature (below 160° F.) lye peeling is a feasible commercial operation that results in reduction of peeling loss and trimming labor as compared with abrasion peeling. These advantages are limited slightly by a decrease in resistance to spoilage and the occurrence, in large-scale operations, of occasional areas of surface cooking. These advantages are unobtainable with early-crop White Rose potatoes. Because of thin skins, shallow eyes, and regular shape of this variety, they can be peeled by abrasion with high product yield and low trimming cost. (b) Rapid cooling of pre-peeled potatoes is essential to obtain maximum protection against microbial spoilage. Refrigeration of the treating solution is a practical method for reducing product temperature to 40° F. within a few minutes for french-fry sticks. On the other hand, whole potatoes will not cool fast enough by this means and can best be cooled by adequate circulation of cold air in refrigerated storage rooms. (c) If desirable, color intensity of french-fried potatoes can be reduced by a hot-water blanch before frying. (d) Undersized potatoes and small cut pieces that are not suitable for french-fry sticks can be processed to make salable hash-browned potato stock for use in restaurants.

[a] Granny Goose Pre-Pared Potatoes, Oakland, Calif.

72

EFFECT OF SUGAR SYRUP LEVEL ON THE QUALITY OF CANNED SWEET POTATOES

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Canned sweet potatoes of 4 different cut out sugar syrup levels, namely 18°, 23°, 28°, and 31° Brix were studied during 18 months' storage at 40°, 72°, and 100° F. A consumer panel expressed preference for sweet potatoes of the higher sugar levels, the highest rating being assigned to the 28° and 31° Brix levels. A slightly lower rating was received by the 23° Brix sugar level; however, the latter sample rated significantly higher than the 18° Brix pack. The 23° and 28° Brix packs demonstrated the greatest resistance to texture breakdown. The effect of temperature on product quality is discussed.

73

STUDIES ON THE DEHYDRATION OF LIMA BEANS

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The effect of three processing factors and two storage conditions on the organoleptic acceptability and storage stability of dehydrated lima beans was investigated. The small seeded Clark's bush variety was grown, harvested and shelled in a commercial viner for this purpose. The beans were blanched in water at 2 temperatures and sulfited by dipping in solution at 3 concentrations. Two temperature schedules were employed for the initial dehydration. After finish drying to different moisture levels, the samples were placed in storage at 70° and 115° F. for periods up to 6 months. The experimental conditions were replicated four times and the results were statistically analyzed.

74

FACTORS AFFECTING THE UPTAKE AND DISTRIBUTION OF SULFITE IN SWEET CORN DURING PREPARATION FOR DEHYDRATION

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A study was made on the effect of certain chemical, biological, and processing factors upon the uptake of sulfite by sweet corn from an aqueous solution of the sodium salts. The effect of the several variables investigated was noted by determining the amount of sulfite absorbed by the gross sample of cut sweet corn, by subgroups divided as to particle size, and by specific portions of the corn kernel. The mode of entry of the sulfite into the corn kernel was of major interest. The change in magnitude and distribution of sulfite in the sample particles during drying and storage was also studied. Comparisons were made between sulfite concentration in dried corn and the color of a water soluble extract.

75

THE EFFECT ON THE FLAVOR OF CANNED AND FROZEN ASPARAGUS OF THE HERBICIDE, KARMEX-W

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The herbicide, Karmex-W, was sprayed at the rate of 2lb./acre on the test plots. Half of each plot was left unsprayed as a control. Samples were harvested daily for the first week of the growing season, and at weekly intervals thereafter.

After harvest the asparagus was frozen and canned, according to procedures specified for small operations, for subsequent

flavor evaluation. A commercial canner supplied canned asparagus from treated and untreated plots.

Flavor evaluations were made at the end of 5-month and 9-month storage periods using a triangle test procedure.

76

PREPARATION OF TASTY VEGETABLE PRODUCTS BY DEEP FAT FRYING

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Tasty vegetable chips, similar to potato chips, have been made from beets, carrots, and parsnips. Deep-fat-fried pea and lima bean embryo chunks have been prepared from overmature canning or freezing varieties of peas and lima beans, and these had a delectable nut-like flavor. The best conditions of cooking (time, temperature, and slice thickness) have been worked out for these products.

The 5 vegetable items have been evaluated by both small and large informal taste panel groups for product quality and possible application. Although there were individual preferences for one product or another, on the whole they were greatly relished by the tasters and considered readily acceptable for snack items or fresh vegetable substitutes in a meal. A cooking oil of great stability gave products which retained their high quality after months of storage.

The oil contents and yields of the fried vegetables have been found and a method of partial degreasing has been proposed. Crude protein values were also determined. Fried peas and lima beans are highly nutritious food items with about 20% protein and 30% oil contents. Carotene studies made on fresh and fried carrot slices showed carotene losses on frying but the fried slices were still very rich in this pro-vitamin A factor.

Ground peas or lima beans with smoked flavoring ingredients made excellent soup mixes which could be readily rehydrated in about 3 minutes.

77

APPERT AWARD ADDRESS

CHARLES GLEN KING

78

EXTENSION OF FOOD STORAGE LIFE BY IRRADIATION

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Certain meat and vegetable products have been treated with high-voltage cathode rays for purposes of extending storage periods at refrigerator temperatures above freezing. Organoleptic evaluation indicated that certain foods treated in this manner may be held at refrigerator temperatures for periods lasting from several weeks to several months without significant differences in acceptability. Bacterial increases and peroxide values of lipoid components were also investigated.

79

THE EFFECT OF GAMMA RADIATION ON THE BAKING QUALITY OF SOME WHEAT FLOURS

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The effect of gamma radiation on the baking quality of some wheat flours was investigated to explore the feasibility of gamma irradiation of stored wheat and wheat flour for the control of insect infestation. Bread, cake, and all-purpose flours were each given a range of doses of gamma radiation and bread, biscuits, and cakes were prepared from the irradiated flours. Taste panel tests were made using the incomplete block ranking procedure.

Bread loaves made with 20,000 rep bread flour were equal to those made with the nonirradiated flour in all respects except in total volume, in which the 20,000 rep loaves were slightly smaller. Bread flour given a dose higher than 50,000 rep was considered to be undesirably altered by gamma radiation.

Cakes made with irradiated bread flour were progressively of poorer quality with increasing doses of gamma radiation.

When making biscuits with irradiated flour receiving 20,000 to 150,000 rep, it was necessary to add more fluid to obtain a workable dough. This dryness of irradiated flour was also noticed when mixing cakes. Biscuits made with irradiated flour had a satisfactory appearance but the eating qualities and flavor of those given higher radiation dosages were not equal to those of the controls.

Cake flour, all-purpose flour, and bread flour were considered to be unchanged when given a dose of 20,000 rep gamma radiation. Cakes made with these different flours were similar to the controls in all respects. At 20,000 rep, flour insects and weevils are destroyed and insect eggs are made sterile.

80

STUDIES IN THE COLD STERILIZATION OF LIQUID FOODS USING MERCURY RESONANCE RADIATION. I. MILK

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A preliminary investigation has been made on the irradiation of milk of uniform film thickness and at various temperatures and flow rates with a mercury-in-quartz rare gas resonance discharge source. This special source emits well over 90% of its energy at the 2 resonance lines of mercury. The intensity of the source was varied by changing the input voltage to the primary of the lamp transformer. Constant intensity for any given input voltage was maintained by interposing a sola constant voltage transformer between the line and the variac transformer.

Milk was chosen for these initial studies because of its recognized delicate taste characteristics and its familiar susceptibility to the development of so-called "activated flavor."

In these preliminary studies, the standard bacterial plate count of raw whole milk was found to be reduced to essentially zero in irradiation periods of from 1 to 10 seconds duration at approximately 5° C. Some activated flavor was encountered. However, methods have been developed whereby these flavors have been markedly reduced in intensity and in some cases essentially eliminated.

No studies have yet been made on the influence of such irradiation upon nutritional factors nor on the possibility of toxic products forming, as a result of the bactericidal action. Further work is planned with the objective of evaluating the resonance source for various liquid foods. If successful, the advantage over higher energy ionizing radiation is obvious. Immediate objectives include a thorough study of the action of resonance radiation on the milk system.

81

THE EFFECTS OF IONIZING RADIATIONS ON THE PROTEIN COMPONENT OF FOODS

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Solutions of purified proteins (casein, ovalbumen, and gelatin) were irradiated in a high energy cathode beam produced by an 8 M.E.V. linear accelerator. The physical and chemical changes occurring in these proteins were studied by means of enzyme reaction rates, viscosity, and electrophoresis mobility. The effectiveness of ascorbic acid in protecting proteins from the action of ionizing radiations is discussed. These findings are related to the cold sterilization of milk, eggs, meat, and other foods.

82

APPLICATIONS OF RADIOISOTOPE TECHNIQUES TO COMMISSARY RESEARCH

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Radioisotope techniques have been applied in many varied and unique ways to problems of commissary research, which can be considered as work on the improvement of feeding, including food preparation, its service and nutrition. Cleanliness is an important aspect of any food operation, and radioisotopes have proved useful in the quantitative measurement not only of cleanliness but the effectiveness of the machines used for cleaning, the efficiency of detergents, and the cleansability of varied types of surfaces. Many of the equipment items used in food work, such as mixers, grinders, and dispensers, depend on efficient and homogeneous dispersion. Radioisotopes can be used to evaluate this mixing operation and to determine the optimum time for its completion. In food packaging there is always concern regarding the permeability of the packaging material to vapors, such as moisture, carbon dioxide, oxygen, or refrigerator odors. Radiotracers provide an excellent means for measuring the penetrability of the various packaging materials to specific gases. Furthermore, autoradiographic pictures of slices of the packaged foodstuffs, when correlated with densitometric standards, provide a quantitative estimate of the amount and depth of penetration. Other applications of the radioisotope technique, including studies on frictional wear, metal solubility of food containers, and tracking the diffusion of moisture or preservatives, are discussed.

83

BROADENING THE QUALITY CONTROL PROGRAM

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Industry's quality needs for the next decade will emphasize competition in product quality as well as price. This intensified quality competition requires that industrial companies broaden their solution to quality problems. The narrow, over-emphasis on the single tool of statistics must give way to a full utilization of *all* management tools for quality control—sound organization, quality planning, programs of defect prevention, campaigns for quality-mindedness, improved processes and measurement, planned vendor relations, programs for improved customer relations, and coordination of all company quality activities.

84

QUALITY CONTROL ON MEAT PRODUCTS

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The relatively large number of variations present in the raw materials in the food field present a great challenge when these materials must be processed into standard products having a standard quality level. Among the tools of real value for this task are the laws of probability and the statistical evaluation of numerical values corresponding to those quality aspects in which we are interested. The quality of finished meat products is completely dependent on the quality of raw material and the quality of the workmanship in adding value through manufacture. Quality can be defined as a collection of those attributes most satisfactory to the consumer. This quality level may be controlled by inspection of raw materials, processing procedures and finished product. These inspection procedures should be based on written standards or specifications.

Among the most important factors in a successful program are the abilities of the quality control personnel and the manner in which the organization is operated. The development of a company quality attitude is of utmost importance. This is done by educating the employees with an on-the-job training technique. This education is extended to the greatest possible number of employees by the quality control group when they investigate and solve production line problems. The quality control training program uses an approach that translates technical matter into language that promotes the quality attitude. It is vital that the supervisory group accepts the fact that the quality control program is not a police function but a quality attitude function which is there to help them produce quality goods.

85

ADAPTATION OF AGTRON (MODEL F) TO CONTINUOUS COLOR MEASUREMENT OF TOMATO JUICE

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During the years 1953 and 1954, the Agtron Model F was used to evaluate the color of raw and processed tomato juice. A high correlation was found between single Agtron F color readings and continuous Agtron F color readings.

The Agtron color evaluations were also correlated with the Hunter Color and Color Difference Meter. The relation of Agtron color readings to U.S.D.A. subjective color evaluation is discussed. Some of the factors involved in the adaptation of a single reading instrument to a continuous reading instrument are also discussed.

86

EFFECT OF TIME-TEMPERATURE HISTORY ON THE ASCORBIC ACID CONTENT OF CONSUMER-SIZE COMMERCIALLY PACKED FROZEN STRAWBERRIES

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Data are presented to show the variation in original amount of reduced ascorbic acid found in several different samples of commercially packed frozen strawberries representing various packing plants, production areas, seasons, and varieties. These samples were subjected to various steady and fluctuating temperatures in addition to time-temperature patterns designed to simulate actual retail distribution practice. Fairly rapid losses in ascorbic acid occurred at temperatures of 10° F. (−12.2° C.) and above, but retention of the acid during storage under these temperature conditions was markedly affected by the type of packaging material.

87

EFFECT OF TIME-TEMPERATURE HISTORY ON COLOR DISTRIBUTION IN CONSUMER-SIZE COMMERCIALLY PACKED FROZEN RASPBERRIES

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A detailed procedure for the determination of color distribution in sirup-packed frozen raspberries is described. Little or no change in color distribution between berries and sirup occurred during storage at 0° F. (−17.8° C.) for one year, but temperatures of 10° F. (−12.2° C.) and above caused a marked color transfer from berries to sirup. These changes are quantitatively expressed as a fruit:sirup color ratio which may be used as a guide in estimating the time-temperature history of frozen raspberries.

88

FACTORS IN PROCESSING METHODS WHICH AFFECT THE QUALITY OF DEHYDROFROZEN APPLE SLICES

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Results of a critical examination of two vital steps in the preparation of dehydrofrozen apple slices are reported: impregnation of slices with sulfur dioxide and removal of excess sulfur dioxide during dehydration. Internal browning was preventable

by careful control of sulfite concentration and dipping time. The minimum treatment needed to prevent internal browning in 4 varieties of apples, relations between time and sulfur dioxide concentration in the sulfite tank, effects of soluble solids build-up in the tank, effect of pH of the sulfiting solution, and effects of other factors are discussed. The degree of removal of excess sulfur dioxide from slices during dehydration was found to be dependent chiefly upon relative humidity of the drying air. Relations between surface texture, relative humidity and loss of sulfur dioxide, relations between relative humidity, internal piece temperatures and dehydration rates, and effect of processing delays upon sulfur dioxide removal during dehydration are presented. Industrial application of these findings will be discussed also, including means for obtaining uniform treatments of slices, for removing sulfur dioxide fumes from the plant, and extension of dehydration data to commercial types of dehydrators.

89

DEHYDROFROZEN APRICOTS

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A process for the production of dehydrofrozen apricots of bright color and natural flavor, by controlled sulfur dioxide treatment prior to dehydration, is presented. Various possible means for preventio.. of browning, such as the use of aqueous solutions of sulfur dioxide, aqueous solutions of other salts, sulfur dioxide gas, and steam scalding are compared as to the quality of the resultant product. Modifications in pie baking and preserve making procedures needed for use with dehydrofrozen apricots are discussed, and the quality of pies and preserves made from this product will be compared with those made from conventionally frozen apricots. It was found that many observers were unable to detect the presence of sulfur dioxide in the ultimate product when apricots were dehydrofrozen by the recommended procedure, *i.e.*, 50% weight reduction and containing 70 to 100 p.p.m. sulfur dioxide after completion of dehydration. The results of commercial trial runs with commercial prune dehydrators for dehydration will be reported.

90

COLOR CHANGES IN STRAWBERRY JELLIES

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Changes in color and pigment content of strawberry jellies were studied as functions of the amount of heat applied in processing and storage. Jellies prepared by vacuum process were stored under normal and accelerated storage conditions and evaluated by anthocyanin analysis and determination of C.I.E. brightness values obtained by reference to spectral reflectance data. The results seemed to indicate that short cooking times at elevated temperatures cause a greater color loss than do equivalent thermal processes at lower temperatures. The analysis of jellies held under accelerated storage conditions similarly do not provide a means for estimating storage life at ordinary temperatures. Under conditions studied, C.I.E. brightness values showed significant correlation with both the percent pigment loss and the ultraviolet optical density due to the formation of sugar degradation products.

91

VOLATILE REDUCING SUBSTANCES IN CANNED BARTLETT PEARS

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The influence of ripeness of fresh Bartlett pears on flavor and quantity of various volatile reducing substances in the canned product was investigated. Accompanying ripening at 68° F. there was a gradual increase in methyl alcohol, total carbonyl compounds, acetyl methyl carbinol and diacetyl content. The rate of production of such compounds was especially rapid when the pressure test of the fresh pears dropped below 2 pounds. The presence of an excess of methyl alcohol and diacetyl might be used as a criterion of off-flavor and overripeness. The presence of excess methyl alcohol in overripe Bartlett pears was thought to be caused by de-esterification of the methyl ester group of the pectin molecule by the enzyme pectin-esterase.

92

ROLE OF ORGANIC ACIDS, SUGARS AND PECTIN ON QUALITY OF CANNED BARTLETT PEARS

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Bartlett pears were ripened to different pressure tests and canned according to commercial procedure. Organic acids analyses of these samples were made by silica-gel column and paper chromatography. Results indicate malic and citric are the major acids present in canred Bartlett pears. Ripening at 68° F. was accompanied by a rapid decrease of malic acid and very little change of citric acid. Presence of minor acids is indicated. Paper chromatographic analysis shows glucose, fructose, and sucrose are also present. Accompanying ripening, there was a decrease of protopectin and an increase of soluble pectin. The intrinsic viscosity, neutral equivalent, and methoxyl content of the versene-extracted pectin decreases as the pears ripen, indicating glycosidic hydrolysis by polygalacturonase and de-esterification by pectin-esterase. The role of these constituents on flavor and texture of the canned pears is discussed.

93

FERMENTATION AND CURING OF CUCUMBERS IN LOW SALT BRINES

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Previous studies by the authors have shown that there are 5 species of lactic acid producing bacteria that may develop in cucumber brines. The influence of each is determined by the conditions of fermentation. Pure culture inoculation with the various species has demonstrated the desirability of a partially heterofermentative fermentation. Since inoculation is impractical under commercial conditions, a study of factors conducive to an active fermentation by the two heterofermenters has been made. Review of previous work showed that 5% salt was inhibitory to these bacteria and of course cucumbers will sometimes soften in 2 or even 2.5% salt. The studies were therefore conducted in 3 to 4% salt concentration. In some of the first experiments additional salt added too early inhibited the fermentation and curing. Experiments in 1953 in both barrel and tank lots demonstrated the development of the several species in natural sequence producing results which were uniformly successful. Again in 1954 excellent results have been obtained in 6 of the 7 tanks of cucumbers. The somewhat varied results which were obtained in barrels in 1954 may be related to maturity of cucumber stock.

94

FURTHER STUDIES ON THE CURING OF CUCUMBERS AND THE DEVELOPMENT OF GREEN COLOUR IN FINISHED PICKLES

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Retarded fermentation during the curing of cucumbers has been attributed in several instances to antibiotics produced by spore-forming bacteria. These antibiotic substances were particularly effective against species of *Leuconostoc* and *Streptococcus* but their effectiveness was variable against species of *Lactobacillus*. These abnormal fermentations were noted in brines of lower salt concentrations. No stoppage of fermentation was observed in brines in concentrations of 6 to 7.5% salt.

Spore-forming bacteria isolated from pickle brines developed rapidly in brines with concentrations of 3 and 5% salt but disappeared rapidly in brines of 6% and higher concentration of salt.

The rate of acid production during the curing process was dependent on a number of factors including the size of cucumbers, the rate of filling vats, and to a considerable extent to combined conditions of salt concentration and temperature.

A continuation of studies on the development of green colour in cured cucumber stock showed that copper applied to plants or to the soil in the form of copper sulphate sprays had a profound influence on the development of green colour in the finished product.

95

THE BACILLUS MACERANS-POLYMYXA GROUP OF BACTERIA AND SOFTENING OF CUCUMBERS AND OLIVES

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Bacteria of the *Bacillus macerans-polymyxa* group ferment sodium polypectate, purified pectic acid and D-galacturonic acid with copious gas formation if supplied with the usual nutrients *in vitro*. These bacteria can cause softening of fermenting cucumbers and olives. The conditions (effect of pH, salt, *etc.*) under which softening can occur are described in detail.

96

A STUDY OF THE ACID-FORMING BACTERIA FROM CUCUMBER FERMENTATIONS IN MICHIGAN

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During the cucumber brining seasons of 1953-54 a total of 848 cultures of acid-forming bacteria were isolated from 78 cucumber fermentations. This collection was screened and grouped and representative cultures from each group studied in detail. On this basis, the groups were identified as follows: *Pediococcus cerevisiae*, 284 isolates (33.5%); *Lactobacillus plantarum* (Group A), 174 (20.5%); *L. plantarum* (Group B), 159 (18.7%); *Lactobacillus brevis*, 188 (22.2%); unclassified, 43 (5.1%). The culture of *L. plantarum* in Group A reduced nitrate while those in Group B did not. As to sequence, only *Pediococcus cerevisiae* was found to have a very definite place in the fermentation. More than 90% of the *Pediococcus cerevisiae* cultures were isolated during the first 10 days after brining of the cucumbers. This species predominated during this period. The other three major groups were isolated from all stages of the fermentations studied—up to 40 days. The addition of 0.05% or 0.1% sorbic acid to cucumber fermentations had no evident effect on the type of lactic acid bacteria isolated.

97

STABILITY OF CUCUMBER PEROXIDASE IN SALT STOCK PICKLES DURING CURING, FRESHENING, AND PACKING

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The stability of cucumber peroxidase was determined in pickles from the time of harvesting throughout the salting, storage, and freshening procedures and finally after varying storage periods of the finished pickle product.

Although in the first few days after salting and covering the concentration of peroxidase in the pickles exceeded that in the brine, equal amounts were present in both brine and pickles within 7 days. The same relative concentration was maintained throughout the 7½ months of storage as salt stock.

From their initial high concentration, peroxidase levels decreased slowly for approximately 2 months before reaching a concentration that remained constant throughout the remainder of the storage period.

Although peroxidase was demonstrated to be present in the freshened salt stock, there was no demonstrable activity in any of the pickles after being commercially manufactured into five different pickle products. Subsequent examinations of samples from these packs indicated no peroxidase regeneration within a 7-month storage period at room temperature.

98

GROWTH AND PECTOLYTIC ACTIVITY OF SOME TOMATO MOLDS AT DIFFERENT pH LEVELS

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A total of 25 molds isolated from tomatoes, belonging to the genera *Aspergillus*, *Botrytis*, *Colletotrichum*, *Fusarium*, *Mucor*, *Oospora*, *Penicillium*, *Rhizoctonia*, *Rhizopus*, and *Trichoderma* were examined for pectolytic activities and growth at different pH levels. The pectolytic activity was determined by viscosity measurements and growth was determined by weighing the mold mats. The relationship between pH, pectolytic activity, and mold growth was established.

99

CURRENT STATUS OF U.S. ARMY QUARTERMASTER RADIATION STERILIZATION PROGRAM

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The Government's program to investigate the possible use of ionizing radiation has been placed in the hands of the Quartermaster Corps and is now in its second year of operation. Initial work has been of an exploratory nature and necessary avenues of further research are opening up.

Initially acute toxicity tests of irradiated foods have been conducted with the cooperation of the Surgeon General and contractors. Test tasting of prepared foods was conducted at the Institute as recipes for preparing irradiated foods were prepared prior to feeding volunteers on an irradiated diet for a period of 4 weeks.

Investigations have been made concerning dosages required for commercial sterility, nutritional changes, and changes in flavors, colors, and odors. Some basic work is also being conducted in the use of additives to prevent certain changes or to offset undesirable flavors and odors that develop.

100

AN EVALUATION OF RADIATION SOURCES AS MEANS FOR PROCESSING FOODS

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Use of ionizing radiation as a means of sterilizing foods and pharmaceuticals has proved feasible, although many problems remain to be worked out before such a process is generally accepted in Industry. The large doses required for sterilization require dose rates to be very high, and this can be accomplished only with powerful electron accelerators or gamma sources whose strength is measured in kilocuries. At present, the only electron sources available have limited penetration potentialities, but in the near future, machines producing electrons of greater energy may be available. Gamma source strengths required for sterilization within reasonable time are measured in kilocuries. Present sources of required intensity are limited, but may be expanded as the science and technique of separation of fission products and reactor design progress.

At present, there are two principal gamma sources available for the Radiation Sterilization Project, one at the MTR in Arco, Idaho, and one at Dugway Proving Ground. An additional facility is now being completed at Argonne National Laboratory under the direction of Dr. Philip Fineman. Electron sources are

located at High Voltage Engineering Corporation in Cambridge, and at General Electric's X-Ray Division at Milwaukee. An additional facility will be available at the Applied Radiation Corporation in Walnut Creek, California. A description of the potentialities and limitations of each source is covered.

A glimpse into the future shows that there are such possibilities as mobile reactors or megacuries gamma sources, or more powerful electron accelerators. A brief description of these is outlined and a discussion of the possibility of establishing such facilities is included.

101

NUTRITIONAL AND BIOCHEMICAL EFFECTS OF RADIATION

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For any practical use of radiation sterilization of foods, it is of obvious importance that the products meet rigid standards of nutrition and acceptability. Although the total amount of chemical change produced by sterilizing doses of ionizing radiation is small, specific nutrients are destroyed to varying degrees, and the possibility of the production of unwholesome compounds exists.

Long term feeding studies in which the butterfat portion of the experimental diet has been irradiated are being carried out, with special reference to the possible presence of injuries, or especially, carcinogenic compounds. A vitamin E deficiency has been observed in other laboratories, when irradiated meat was the experimental diet. A slight decrease in reproduction, partially remedied by vitamin E supplementation, has been found in our experiments. A slight growth decrease has been noted in some experiments in animals fed the experimental diet even when vitamin E has been furnished. However, no evidence of specific abnormalities was observed by an experienced pathologist upon examination of the tissues of the experimental animals.

Related studies concerning the destruction of some of the nutrients in milk showed vitamin A, the tocopherols, and ascorbic acid to be highly sensitive to destruction at sterilization doses: the carotenes and riboflavin were moderately sensitive. Similar results were obtained with other dairy products. Oxidative changes induced by radiation in various fats have been observed. Detailed studies of the radiation induced oxidation of ascorbic acid indicate a reaction mechanism that does not involve chain utilization of oxygen.

102

EFFECT OF IRRADIATION ON THE SPORES AND TOXIN OF CLOSTRIDIUM BOTULINUM

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Soft surface ripened cheese samples were inoculated with spores of *Clostridium botulinum* and irradiated at various dosages of gamma irradiation with Cobalt-60. The spores of one type B strain were inactivated by lower dosages than were the spores of any of the 3 type A strains tested. In general, type A spores were inactivated by 800,000 to 1,100,000 rep and type B spores by 550,000 rep. Results from experiments designed to study the effect of irradiation with Cobalt-60 on the toxin producing ability of spores showed that this characteristic was unaltered by sub-lethal dosages.

In the trials with broth or cheese containing *Cl. botulinum* toxin, the toxicity was assayed at 3 levels; namely, 1,000, 200 and 20 m.l.d.

There was no apparent differential influence on the rate of inactivation of the toxin in trypticase broth, whether the atmosphere above the broth in the sealed tubes was CO_2, a mixture of 90% N_2 and 10% CO_2, or air. Similarly, the pattern of inactivation for toxin in beef heart broth appeared to be the same as for the toxin in trypticase broth. In broth, where the initial toxin level was somewhat above 20 m.l.d., reduction of the toxicity to the endpoint (less than 20 m.l.d.) required at least 2,200,000 rep. When the initial toxicity was above 200 m.l.d., reduction to below 20 m.l.d. required at least 4,200,000 rep. Toxin levels above 1,000 m.l.d. were not reduced to below 20 m.l.d. by less than 4,300,000 rep., and in most instances at least 5,300,000 rep. were required.

Type A. *Cl. botulinum* toxin added to cheese required higher levels of irradiation to reduce the toxicity to below 20 m.l.d. than was observed with toxin irradiated in a broth medium. In cheese, where the initial toxin level was above 1,000 m.l.d., reduction of the toxicity to below 20 m.l.d. required at least 7,800,000 rep.

103

CONCOMITANT USE OF RADIATION WITH OTHER PROCESSING METHODS

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The concomitant use of ionizing radiations with conventional processing methods such as cooking, dehydration, freezing, and gas packaging on the development of the "irradiated" flavor in meat products packed in No. 2 cans has been investigated. Radiation was carried out at the Materials Testing Reactor, Idaho Falls, Idaho. Gamma flux intensities have been used to yield dosages of 2×10^6 rep. The irradiated meat products have been evaluated by means of taste test panels where results could be analyzed statistically.

In all tests with hamburger, frankfurters, and bologna the flavor score of the non-irradiated samples was significantly higher than any of the irradiated samples. Results thus far show that the flavor developed by irradiation in fresh unfrozen hamburger canned without exclusion of air is statistically no different in intensity than when the hamburger is irradiated while frozen or canned in vacuum or in nitrogen, or after partial or complete cooking (with or without additional dehydration). There was no significant difference among any of the conventional processing procedures which were coupled with irradiation. The intensity of the gamma flux and time (27 minutes to 24 hours) required to achieve 2×10^6 rep appear to have no influence on the intensity of the irradiated flavor.

Evaluation of unseasoned ground pork has shown that trained tasters familiar with irradiated flavor could not distinguish between irradiated and non-irradiated samples. Of the 30 processing variables tested, the only effect lies in that of partial and complete cooking prior to irradiation. Such pretreatment significantly lowered the flavor score. Large panel preference tests using over 100 untrained tasters have been conducted.

104

EFFECT OF PRETREATMENT AND TYPE OF PACKAGING MATERIAL ON THE QUALITY OF FRESH AND FROZEN BROILERS

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The research was divided into 2 studies: in one, frozen broilers were evaluated; in the other, broilers stored in an open refrigerated display case were evaluated.

New Hampshire broilers, 13 weeks old and of similar heredity were used. After evisceration and ice slush cooling, 144 birds were held at 34° F. overnight. The broilers were cut up and the thighs, legs and breasts used for this study. Prior to packaging in polyethylene, or cry-o-vac, or aluminum foil, the birds received one of the following treatments:

a. Floured and deep fat fried in peanut oil at 375° F. for 3 minutes.

b. Floured and deep fat fried in peanut oil at 375° F. for 10 minutes.

c. Untreated controls.

The broilers were frozen at —30° F. for 24 hours, then stored at 0° F. Tests were made on samples after 0, 5, 10 and 15 weeks of frozen storage.

In the second study, fresh dressed broilers obtained from a commercial source were used. Untreated controls were compared with birds that had been floured and deep fat fried in peanut oil at 375° F. for 10 minutes prior to storage in an open commercial refrigerated display case. Only one type of packaging was used and treated and untreated samples were tested after 1, 2, 3, and 4 days of storage.

Data recorded in both studies included weight losses during storage and cooking losses. The relationships between drip losses and type of packaging and between drip losses and pretreatments were determined.

The effect of packaging, type of pretreatment and length of storage on the quality was evaluated subjectively. Tenderness, juiciness, skin flavor and meat flavor were scored by a sensory taste panel of seven judges. The results obtained are reported. The off-flavors that developed in the precooked samples will be discussed.

105

EFFECT OF FLUCTUATING TEMPERATURES ON FROZEN TURKEYS

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Quality deterioration in ready-to-cook broad-breasted bronze turkeys was studied over a period of 18 months as a function of packaging, scalding temperature, and experimental temperature conditions consisting of constant temperatures of —30°, —10°, 0°, and + 10° F., and a temperature that fluctuated from —10° to +10° to —10° F. in a 24-hour sine wave cycle. Moisture loss from a relatively permeable package increased in expected fashion with increase in temperature. The loss for the fluctuating temperature condition corresponded to the loss estimated for storage at a constant temperature of 3° F. In relatively impermeable packages frost formation in the package increased with temperature, and for the —10° to +10° F. fluctuation was considerably greater than for the highest (+10° F.) constant temperature. Turkeys scalded at 140° F. developed almost twice as much frost as birds scalded at 126° F. Deterioration in flavor likewise increased with increase in storage temperature from —10° to +10° F., but it was not possible to distinguish between samples stored at 0° F. and those stored under the fluctuating condition. In this temperature range (—10° to +10° F.) and in relatively impermeable packages the principal effect of periodic temperature fluctuations is an increase in the frost formation within the package.

106

TENDERNESS IN POULTRY MEAT. I. AN IMPROVED METHOD OF MEASURING

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With the many new developments in poultry processing there arises the question of effect of these on the quality of the poultry, particularly tenderness. Present methods of measuring tenderness leave much to be desired, being either too inaccurate or too time-consuming to permit adequate sampling.

This paper describes the procedure developed in the Birds Eye Laboratories for the measurement of tenderness of broiler meat based on the use of the Kramer Shear Press. Results when compared with organoleptic ratings, gave a correlation coefficient of 0.975. The procedure is rapid, permitting use of a sufficient number of samples to reduce error to any reasonable degree. It has been a valuable tool in evaluating the effect of process changes on tenderness.

107

THE PRODUCTION OF POULTRY SPECIALTY ITEMS

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It is the opinion of the authors that major emphasis during the next decade in poultry research will be placed on the development of poultry specialty products. The potential value of this research to consumers and to the poultry industry is indicated. Poultry specialty items on the market today are reviewed. Many problems are encountered in the development and manufacture of these items. Some of the technical problems arising in their fabrication are reviewed, particularly in relation to appearance, flavor, yield, and storage of products.

108

A NEW TEST FOR THERMOSTABILIZED EGGS

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Since the attempt to find a method for testing thermostabilized eggs based on the inactivation of enzymes was rather unsuccessful, a new approach to the problem was made on the basis of the stability of phosphates present. The method is similar to the one worked out previously for testing heated milk. It appears from the results obtained from our experiment that during the heating of eggs a reaction between carbonic acid and phosphates takes place similar to that occurring in heating milk. But in the case of eggs the process is more complicated because tricalcium phosphate from the shell seems to take part, also, in a two step reaction as follows:

(1) $Ca_3PO_4 + CO_2 + H_2O \longrightarrow CaCO_3 + 2\ CaHPO_4$
(2) $2CaHPO_4 + CO_2 + H_2O \longrightarrow CaCO_3 + CaH_4(PO_4)_2$

109

THE INFLUENCE OF ENVIRONMENT ON LYSOZYME ACTIVITY IN SHELL EGGS

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It has been established that there are several bacteriostatic properties in eggs. The shell, shell membrane, conalbumin, lysozyme, avidin, the pH level, and the consistency of the albumen are all known to have inhibitory actions on bacteria. This study was undertaken in order to evaluate the influence of environmental factors such as time, temperature and pH upon lysozyme activity in eggs.

In studies on the effect of temperature on changes in lysozyme activity during storage, samples of albumen were pooled for assay in order to minimize individual egg differences. During a storage period of 21 days, lysozyme activity generally decreased after an initial increase. Eggs stored at 25° C. showed a rapid increase with an early peak in activity, followed by a pronounced decline; at 10° C., the increase in activity was more gradual followed by a slower decrease; and at 1.5° C. the lysozyme activity increased at a gradual rate for at least 21 days.

Preliminary observations indicated that the per cent of eggs infected and bacterial counts appeared to be more closely related to storage temperature than to lysozyme activity or to pH of the albumen. In concentrations approximating those found in fresh egg albumen, purified lysozyme preparations did not cause lysis of several strains of *Pseudomonas*.

110

THE MONOMOLECULAR SURFACE FILM METHOD FOR DETERMINING SMALL QUANTITIES OF YOLK OR FAT IN EGG ALBUMEN

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A monomolecular surface film method for quantitatively measuring small quantities of fat in skim milk was modified to determine the fat (or yolk) content of egg albumen. This method measures the quantity of fat by the area of its monolayer on a specially prepared acid solution surface. The spreading coefficient of egg oil was found to be 1.03 micrograms per square inch. The recovery of egg oil from samples to which known amounts of yolk had been added was excellent even after various storage and handling conditions. The method proved to be simple and yet was found to be highly accurate.

111

THE PHYSICAL AND FUNCTIONAL PROPERTIES OF LYOPHILIZED WHOLE EGG, YOLK AND WHITE

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There was no difference in the solubility index of spray dried and lyophilized plain and enzyme desugared whole egg, yolk, and white. Angel food cakes prepared with lyophilized, spray dried, and frozen white compared favorably in volume and texture with those prepared with fresh liquid egg white. Fresh liquid whole egg produced the best sponge cakes followed in order by those made with lyophilized and spray dried whole egg. Liquid, lyophilized and spray dried yolk rated in the order listed for making mayonnaise.

112

DETERMINATION OF ENTHALPIES INVOLVED IN FOOD FREEZING

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A Dewar flask calorimeter was calibrated for use in the determination of enthalpy changes involved in freezing and thawing of several food products. Samples of approximately one pound were treated in a manner simulating commercial conditions. The experimentally determined enthalpy values were not significantly different from those calculated using data found in the literature. From an energy standpoint, freezing and thawing of foods yielded essentially the same results.

Several possible sources of error in applying theoretical values to commercial practice are discussed.

113

EFFECTS OF PRE-FREEZING DELAY AND OTHER FACTORS ON THE DRAINED WEIGHT OF FROZEN RSP CHERRIES

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Red sour pitted cherries were packed in 30-pound tins with sugar (5:1) or syrup and frozen. The elapsed time between packing and freezing was varied between 0 and 48 hours. After several months' storage at 0° F., the cans were thawed, and drained weights determined.

When the cherries were frozen at 0° F., the drained weights decreased with the length of delay between packing and freezing. However, when frozen in an air blast at —20° F., there was a slight increase in drained weight with periods of delay up to 12 hours. Better drained weights were obtained when half the sugar was mixed with the cherries than when all the sugar was placed on top.

A method for measuring drained weight of frozen cherries is described. The effects of temperature and time of drainage are discussed.

114

LOSS OF NATURAL GLUTAMATE IN FRESH GREEN PEAS AND OTHER FROZEN VEGETABLES

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Natural glutamate, such as monosodium glutamate, is readily metabolized in the vegetable cell and consequently is labile. As soon as this natural glutamate content is lowered, food flavor is diminished and we say a food has lost its freshness.

Fresh green peas, of optimum maturity for freezing, have a higher glutamate content than many other vegetables. Hence detailed studies were made on this vegetable. With increased tenderometer readings, this natural glutamate content decreases. Continued losses are evident during processing for freezing and in particular during blanching. There appears to be no loss during freezing and subsequent storage at low temperatures.

Frozen peas available in the retail market vary considerably in natural glutamate content. Data are presented on the glutamate content of other frozen vegetables analyzed immediately after purchase.

115

THE EFFECT OF SUNLIGHT ON CRUDE LIPIDS EXTRACTED FROM FRESH AND FROZEN VEGETABLES

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The effect of strong sunlight on the extracted crude lipids of peas, snap beans, lima beans, sweet corn, spinach and asparagus was studied. It was found that lima bean lipid was the most active but lipid from asparagus is the fastest to be acted upon by sunlight. Differences in activity between lipid extracted from blanched and unblanched corresponding lots of the same vegetable are of interest.

116

STUDIES ON THE PRESERVATION OF BREAD BY FREEZING

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Commercial possibilities for the frozen preservation of bread depend on the ability of freezing to preserve freshness qualities, and on the extent to which the extra costs involved can be held to a minimum and compensated for by other changes in production and sales methods. Studies have been made of rates of freezing and thawing under different temperature, air-flow, humidity, and packaging conditions. At the same time the changes occurring in the bread as a result of freezing and thawing have been followed with respect to such physical properties as crumb firmness and moisture distribution, as well as by organoleptic comparisons. Some results of these studies will be reported.

117

DETERIORATIVE CHANGES IN FROZEN SHRIMP AND THEIR INHIBITION

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Changes in the color, flavor, odor, and texture of frozen shrimp develop during the storage period. The first 3 types of changes are apparently due to oxidation. Texture changes are the result of protein denaturation.

A correlation has been shown to exist between fading and development of off-flavors in frozen shrimp; off-odor accompanies off-flavor. Extraction of the pigment has made it possible to determine the wavelength maximum of the red color, and subsequently to adopt a colorimeteric method by which the degree of fading can be quantitatively measured.

Organoleptic testing has been carried out and compared with the objective test for color fading. The fact that the colorimetric measurements give no information on texture has made the organoleptic tests essential.

The effect of various treatments on deteriorative changes will be reported. Treatments include addition of ascorbic acid, butylated hydroxyanisole, sodium chloride, polyphosphates, and liquid smokes; and comparisons of raw versus precooked shrimp.

118

EFFECT OF POST-MORTEM CHILLING ON THE KEEPING QUALITY OF FROZEN PORK

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It is generally believed that pork carcasses should be chilled and processed as rapidly as possible after slaughter. However, there has been no standard pattern for the handling of pork by frozen

food locker plants. The study reported here was designed to determine the effect of 2 temperatures of cooling and 3 periods of hanging pork carcasses on the keeping quality of frozen pork. The temperatures selected, 30° and 40° F., represented practices common in the locker industry, and the hanging periods, 7, 3, and 1 days, represented common practices as well as those considered desirable. Pork loin roasts were tested at 8-week intervals from 0 to 48 weeks of frozen storage.

Both chemical and palatability tests showed that the pork from carcasses hung for 7 days before freezing deteriorated more rapidly than pork from carcasses hung for 3 days or 1 day. There was little difference in the quality of the meat hung for the latter 2 periods. The temperature of cooling had no effect on keeping quality of the pork.

119

KNOWLEDGE OF THE STIMULUS VARIABLE AS AN AID IN DISCRIMINATION TESTS

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Small, trained laboratory panels, despite selection for above-average ability, motivation, etc., frequently fail to discriminate between complex food stimuli where appreciable differences can be demonstrated by other methods such as consumer preference tests. Published suggestions for improvement of the panel test include increase in panel size and change in the basic test methods.

The experiment reported was based on the latter suggestion. The possibilities were explored of lessening difficulty of difference test performance, and hence increasing panel discrimination, by simple manipulation within the framework of the test itself. Specifically, the hypothesis was tested that success in a triangular difference test could be varied according to the type of information given the subject regarding the stimulus variable. Sugar and citric acid were added to orange juice to effect the desired stimulus changes. They were added separately or combined at levels predetermined to yield discrimination near the 5% level of significance when no information was given the test subject. Replicate testing was carried out at various times of day by both panel members and non-panel members.

The hypothesis was substantiated. Generally, physical and psychological terms were equally effective; knowledge of direction of variation did not increase per cent success with either physical or psychological terms; incorrect or misleading information reduced success below the "no-information" level; and panel members performed no differently from non-panel members although technical information given non-panel members was of limited value.

It is concluded that information concerning the stimulus variable aids panel discrimination provided the information is based on common experience and understanding.

120

VARIATIONS IN PREFERENCE RATINGS FOR FOODS SERVED AT MEALS

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This exploratory study of the factors influencing soldiers' stated preferences for a constant food as served at regular meals in the dining hall was designed to investigate four possible sources of variation: (a) the day of the week and (b) the meal at which the food was served, (c) the mess hall used as test site, and (d) the number of foods to be rated on the questionnaire. Information was also obtained on changes from week to week. The test food was orange juice prepared from the dehydrate. Preference was measured by the hedonic scale method. Military teams conducted tests over a period of 3 weeks at 27 different meals in 9 different messes at Fort Lee, Virginia. Each test involved a sample of 25-30 respondents. All 3 daily meals, 3 different days of the week, and 3 questionnaire forms were included.

The over-all range of mean ratings by test session was 2.50 scale points. Analysis of variance showed that the effects of day of the week and number of foods were not significant; however, the effects of both mess-hall and meal were significant at the 1% level. The changes in rating from week to week were negligible. The implications of these findings for acceptance pretesting of military rations are discussed.

121

THE TASTE AND ODOR OF WATER IN D-UNITS, AS A STANDARD MEASURE FOR ACCEPTANCE

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On numerous occasions off-tastes in water have been brought to our attention as problems in non-acceptance. When hospital patients or the general public object to highly chlorinated or otherwise treated water, the water consumption rate is reduced below an optimum. Problems in non-acceptance of *foods* also appear when waters heavy with industrial wastes, or subjected to different kinds of chemical treatment, or of different natural mineral content, are used in food preparation in the home and by food industries. We are concerned especially as to the effect of such waters when used in cooking, and also when used in the reconstitution of beverages, condensed or dehydrated fruit juices or powders, infant formulae, milk powders, or protein concentrates. The problem also would concern food industries because of the increasing production of special-purpose foods low in sodium and of canned foods in water pack.

While the U. S. Public Health Service, the American Water Works Association, and other organizations have been active in developing methods for measuring taste, odor, and potability of municipal and spring water supplies for more than 50 years, this problem will be discussed in terms of today's needs, and with the use of new methods of measuring odor and taste in water.

122

THE ESTABLISHMENT AND USE OF A CONSUMER TASTE PANEL FOR THE EVALUATION OF QUALITY OF EXPERIMENTAL FOODS

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The establishment and use of a consumer panel are discussed in two parts.

Part I. Establishment of a consumer food panel.

The 1950 block statistics for Columbus, Ohio were used to obtain rental value per block and number of dwelling units per block. The panel members were drawn from blocks in an area within a mile radius of the Ohio State University. In selecting the families for this panel, the chosen area was stratified according to income and population trends. High, medium and low income groups were defined and blocks were then chosen at random. The families in these blocks were then canvassed for family members. Three hundred members were selected and statistical data were obtained for each income third. These data were compared to census data for the metropolitan Columbus area.

Part II. The use of a consumer food panel.

The consumer panel had been used to evaluate such products as canned tomato juice, canned cream style and whole kernel corn, potato chips and candy. Consumer preferences have been obtained for these products and these preferences have been compared to specific quality attributes as evaluated by a small laboratory research panel and objective tests. Such attributes of quality as consistency, maturity, flavor, color, and texture have been evaluated by both panels and will be discussed in this paper.

123

APPLICATION OF STATISTICAL PROCEDURES TO RANKING OF SEVEN TOMATO JUICE SAMPLES

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Many workers prefer ranking to scoring for the determination of subjective differences in foods, because of increased consistency of results. The statistical procedures customarily used for scoring are not strictly applicable to ranking. Therefore, modifications were made and applied to ranked data from 7 tomato juice samples which had been stored for 9 months. The juices, which varied in concentration and storage temperature, were ranked

four at a time for flavor (incomplete block), and seven at a time for color (complete block). Several methods of analysis, several procedures for calculation of a least significant difference (L.S.D.) and three probability levels were applied to the data to determine how these changes would alter conclusions drawn about the effects of the treatments of the 7 samples. Flavor ranks and the L.S.D. from the four most consistent judges were approximately the same as results from the entire panel of eight judges. Procedures are described for the determination of relative reproducibility ("internal consistency") of each judge's ranks, and for testing his agreement with the panel as a whole.

124

ORGANOLEPTIC EVALUATION OF APPLE SAUCE FORTIFIED WITH ESSENCE AND CITRIC ACID

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The manufacture of canned applesauce is well-standardized from the standpoint of color and texture. However, since the varieties of apples available are usually limited, the sauce is often a bland, rather flavorless product. Apple essence was added to applesauce in an effort to give more of a fresh apple flavor to the sauce. Citric acid was also added to increase the tartness.

Three types of essence were used: (a) from whole apples of the same blend as was used for the sauce; (b) from by-product peels and cores of the apples used for the sauce; and (c) from whole apples of the dessert type. Each of these essences was added at various levels to determine the optimum concentration required. Various concentrations of citric acid were added in conjunction with the essence addition. A trial series of taste tests was run and the most consistent tasters selected for a trained panel, which then evaluated all samples. In addition, a consumer preference panel tested some of the samples. The statistical analysis of the results is discussed.

Although dessert-type essence imparts too aromatic a flavor, essence from the peels and cores and essence from the whole apples of the same varieties as used in the sauce, both improved the flavor of the applesauce. This improvement was retained during room temperature storage for 10 months. The addition of .1% citric acid to peel and core essence fortified sauce was found to impart an agreeable tartness to the applesauce.

125

THE EFFECTS OF COOLING AND FREEZING PROCEDURES ON CONSUMER ACCEPTABILITY OF TURKEY MEAT

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Turkeys were processed by sub-scald procedures. Carcasses were cooled in slush ice, drained ice, and in air at 34° F. Those in air were covered with a wet canvas shroud or packed in polyethylene bags. Approximately 18 hours after placing the carcasses in the various cooling media, they were removed and together with uncooled turkeys just processed were packaged in polyethylene and frozen at 0°, −20°, or −40° F. in forced air refrigeration.

Weight changes during cooling, freezing, thawing and cooking were recorded for 4 classes of turkeys. Tenderness of breast and thigh muscles was determined, using a tenderometer, for each bird.

It was found that air-cooled birds lost approximately 1% in weight during cooling and slush ice-cooled birds gained from 2 to 4%, depending on age of the turkeys at the time of processing. Much of the difference in weight was accounted for in loss differences during thawing and cooking.

126

RETENTION OF TASTE SENSITIVITY

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In a production line operation the necessity for prompt evaluation of processing samples is readily evident. When production personnel are used to obtain the judgment, efficient operation demands the full utilization of each individual's sensitivity. The duo-trio has been successfully extended to the quadro-trio thereby doubling the number of decisions rendered by each panelist. To determine the duration of the tasting ability with the use of multiple trios, a series of experiments on various beverage products was devised.

127

SIMULTANEOUS VS. SUCCESSIVE PRESENTATION IN A PAIRED COMPARISON SITUATION

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In flavor preference testing of foods, the time interval between presentation of samples to be compared may be an important variable. Methodologies currently employed range from simultaneous presentation of samples to intervals of several days or more.

An experiment was performed to determine whether the length of the interval between samples has any influence upon the direction or degree of preference obtained. Panels of consumers were tested under laboratory conditions, using a variety of soups as the test foods. A series of paired comparison preference tests was conducted in which the inter-sample interval was systematically varied. The degree of difference between the two samples of a pair was also varied so that the effect of a time interval could be determined for both strong and weak preferences.

The implications of these results for both laboratory and consumer testing are discussed.

Physical Properties of Cake as Affected by Method of Butter Manufacture and Addition of an Emulsifying Agent

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Use of butter manufactured by two different methods and with and without an added emulsifying agent was investigated as shortening for plain cake. Fat distribution in batter and in the finished cake was examined by an histological method and specific gravity of batter, weight losses during baking, and area of cross sections of cakes were determined. Little or no difference in physical properties of batter and cakes associated with kind of butter used was evident. Fat distribution in batter and cake was more markedly affected by addition of the emulsifying agent than were other physical properties. The histological method used shows promise for further application.

Various investigators *(1, 2, 10)* have reported that butter is valued as a shortening principally for the tenderness, smooth texture, and distinctive flavor which it imparts to baked products. Butter has compared favorably in baking qualities with other fats and except for its high cost has been considered an ideal shortening for cake.

Advances in shortening technology, such as the development of hydrogenated and superglycerinated shortenings, have given other fats some advantages over butter. The superglycerinated or emulsifier-fats are reported *(1, 5, 6, 10)* to permit the use of cake formulas having a higher ratio of sugar and liquid to flour with the result that cakes are lighter, more moist, sweeter, more tender, and have better keeping qualities than those made with butter or untreated shortenings.

A recent development in dairy technology has been the continuous process for manufacturing butter. Wilster *(11)* points out a number of advantages of this method over the conventional churn process. The two advantages most likely to affect baking quality are control of composition of the butter and distribution of the moisture in exceedingly fine droplets. A previous study by Billig *(3)* indicated that the method of manufacture had little or no effect on the functional properties of the butter.

Favorable reports on the incorporation of emulsifying agents in other shortenings for cake have led to experimentation with emulsifiers added to butter. Jooste and Mackey *(7)* and Billig *(3)* found improved volume in cakes made with butter containing emulsifying agents at respective levels of 3.0 and 3.5% by weight of the fat.

The present study was concerned with the baking performance of butter manufactured by two different processes and with or without the addition of an emulsifying agent. Plain cake was the product selected as a test medium. Properties investigated were the following: (a) fat distribution in cake batter, (b) fat distribution in baked cake, (c) specific gravity of batter, (d) weight losses during baking, and (e) volume of finished cake as indicated by area of cross section.

EXPERIMENTAL

The butter used in these experiments was made either by the conventional churn process or by a continuous process. Both kinds are available in the retail market, but the continuous butter used was obtained directly from the manufacturer.[a] The conventional churn butter was purchased at a local store. The quality of both kinds of butter was 92-score.

The emulsifying agent which was added to some of the butter was in liquid form, of vegetable origin, and had the following characteristics, according to information supplied by the manufacturer[b]:

Melting point	70 to 75° F.
Iodine number	120 to 125
Monoglyceride content	40%
Diglyceride content	50%
Free fatty acid content	1.1 to 1.3%
Free glycerine content	Maximum 1.5%

In referring to the product, the terms "mono- and diglyceride type of emulsifying agent," "emulsifying agent," or "emulsifier" are used in this paper.

The level selected for addition of emulsifier to butter was 3.5% by weight as used by Billig *(3)*. The liquid emulsifying agent was incorporated into a sufficient quantity of each kind of butter to complete the study, using a household mixer with a flat beater-pastry knife operating for 20 minutes at a speed of 216 r.p.m. Portions for each baking were individually wrapped in aluminum foil and stored in a home-type freezer until needed. Butter with no added emulsifier was also beaten and stored in the same manner.

A medium-sugar formula for plain cake *(3)* was used. The amounts of ingredients were as follows: 125 g. fine granulated sugar, 100 g. cake flour, 5.3 g. tartrate-type baking powder, 0.9 g. salt, 13 g. dried whole milk, 50 g. egg, 80 ml. distilled water, and 50 g. of either butter or the combined butter and emulsifying agent.

The ingredients were combined by a modified flour-batter method *(3)* using the household mixer already described. Half of the flour was blended with the fat; the remainder of the flour and all of the sugar, salt, and dried milk were mixed with three-fourths of the water. These ingredients were added gradually to the fat-flour mixture. The baking powder was sprinkled over the batter near the end of mixing. The egg, combined with the remaining one-fourth of the water, was added a little at a time and the batter was thoroughly blended. Two 165-g. portions of batter from each batch were weighed into small tin-coated loaf pans (approximately 5.5 x 3 x 2 inches) and baked at 185° C. (365° F.) for 24.5 minutes. The cakes were cooled for 15 minutes in the pans after removal from the oven.

Specific gravity of batter was determined with a glass

[a] Blue Valley Creamery, Division of Beatrice Foods, Inc., Columbus, Ohio.

[b] Crest Foods Co., Ashton, Illinois.

pycnometer (capacity, approximately 25 ml.) from the batter remaining in the bowl. Losses in weight during baking were found by subtracting the weight of the baked cakes 10 minutes after removal from the oven from the weight of the batter used. An index to volume of the cakes *(7)* was obtained after cooling for approximately 90 minutes by measuring the area of drawings of center cross sections with a compensating polar planimeter.

In order to study the fat distribution in batter and cake, a suitable histological method was developed in preliminary experiments. Previous work on the nature of cake structure has been reported by Carlin *(4)* who made a cinema microphotographic study and by Jooste and Mackey *(7)* who used a histological method involving osmic acid staining of fat and paraffin sections of the cake. In the present study microscopic observation of fat distribution was facilitated by the use of Sudan IV, a red fat-soluble dye. A few granules of the dye were mixed into a small portion of each lot of batter and cover glass smears were prepared. In order to observe the fat distribution in samples of the finished cakes, the senior author prepared small blocks of the cakes fixed in formalin vapor, embedded in gelatin, and sectioned with a freezing microtome at a thickness of approximately 50 microns. The sections were placed in a saturated solution of Sudan IV in equal parts of 70% alcohol and pure acetone. The fat took on a bright red color and was thus easily discerned and distinguishable from other ingredients in the cake when the slides were examined under the microscope. Photomicrographs were made of representative slides of batter and of cake from each variation.

RESULTS AND DISCUSSION

Batters containing either conventional churn or continuous process butter without added emulsifying agent appeared to be well aerated and relatively viscous. Breaking or curdling occurred in all of these batters, but the resultant cakes were quite acceptable in volume and texture. On the other hand, batters made from either the conventional churn or continuous process butter containing added emulsifier were thin and runny, appeared smooth and glossy, and showed no evidence of curdling. These observations concerning the effect of added emulsifying agent on viscosity and appearance of batters agree with those of previous investigators *(3, 4, 7)*. The cakes baked from these batters were also of desirable lightness and fineness of texture. The top surface was slightly rounded and markedly uniform in contour.

As shown in Figure 1, the average specific gravity (0.756) of cake batters prepared from conventional churn butter with no added emulsifier was lower than the average (0.780) found for batters made with continuous process butter with no added emulsifier. Use of either kind of butter to which emulsifying agent had been added resulted in a slightly adverse effect on lightness of batter (specific gravity 0.759 and 0.815 for conventional churn and continuous process, respectively). The thinner consistency and higher specific gravity obtained with emulsifier added to the butters indicated that less air had been incorporated in the batters than when no emulsifying agent was used.

The average percentage of weight lost during baking was the same (6.1%) for cakes made with either conventional churn or continuous process butter with no added emulsifier (Figure 2). With added emulsifying agent, the average weight losses were 5.8 and 5.9%, respectively. These differences were probably too

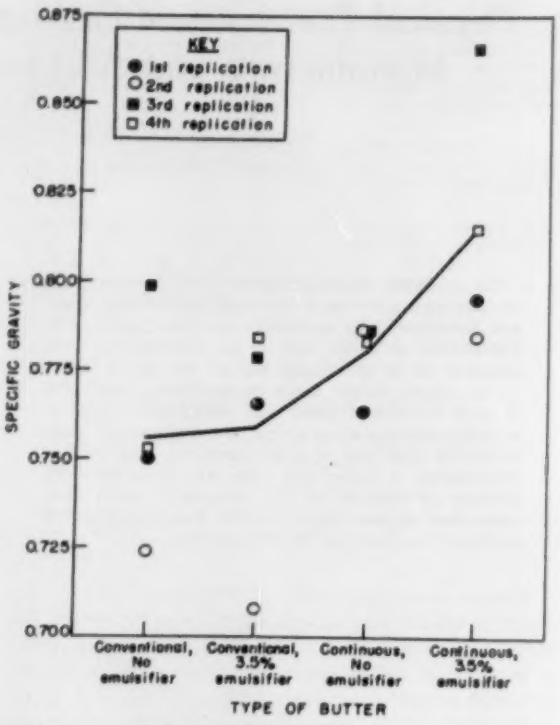

Figure 1. Specific gravity of cake batters made with two kinds of butter and with or without added emulsifying agent.

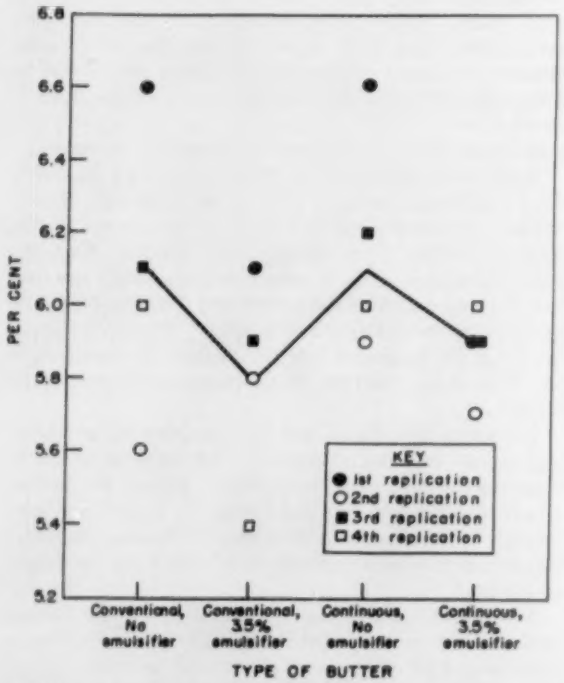

Figure 2. Weight losses (percent) during baking of cakes made with two kinds of butter and with or without added emulsifying agent.

small to represent other than chance variations. Other investigators *(5, 8, 9)* have reported that more moist cakes having improved keeping quality were obtained with addition of an emulsifying agent than with no added emulsifier.

Cakes containing conventional churn butter with no added emulsifying agent were found to have the smallest average cross-sectional area, 5.35 sq. in.; cakes made with continuous process butter containing no added emulsifier had an average value of 5.40 sq. in.; those containing continuous process butter with added emulsifier were 5.46 sq. in.; and the largest average cross-sectional area, 5.73 sq. in., was obtained for cakes made with conventional churn butter containing added emulsifying agent. These results are shown in Figure 3. The averages of cross-sectional area of cakes made with either conventional churn or continuous process butter were slightly less than for the corresponding butters containing added emulsifier. Jooste and Mackey *(7)* and Billig *(3)* found improved volume with the addition of an emulsifying agent to butter used as shortening for cake.

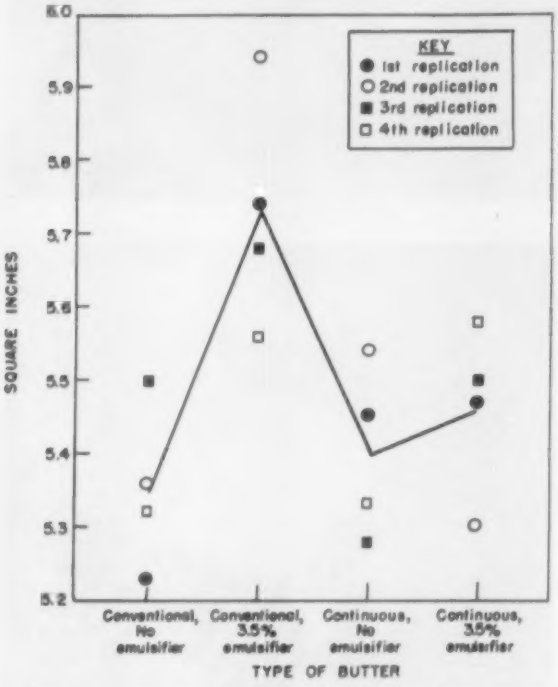

Figure 3. Area (sq. in.) of cross sections of cakes made with two kinds of butter and with or without added emulsifying agent.

Microscopic examination of the fat-stained smears of each cake batter revealed little or no difference in fat distribution with either kind of butter containing no added emulsifying agent (Figures 4 and 5). In each case the fat was dispersed in the aqueous phase of the batter in dark, irregular clumps. Small gas bubbles appeared only in the fat areas. In batters prepared with either kind of butter containing added emulsifying agent (Figures 6 and 7), the fat and the air cells appeared to be evenly distributed throughout the batter. The interfaces between fat areas and the aqueous phase were less sharply defined, and the gas bubbles were less clearly identified with the fat when the butter used in the batter

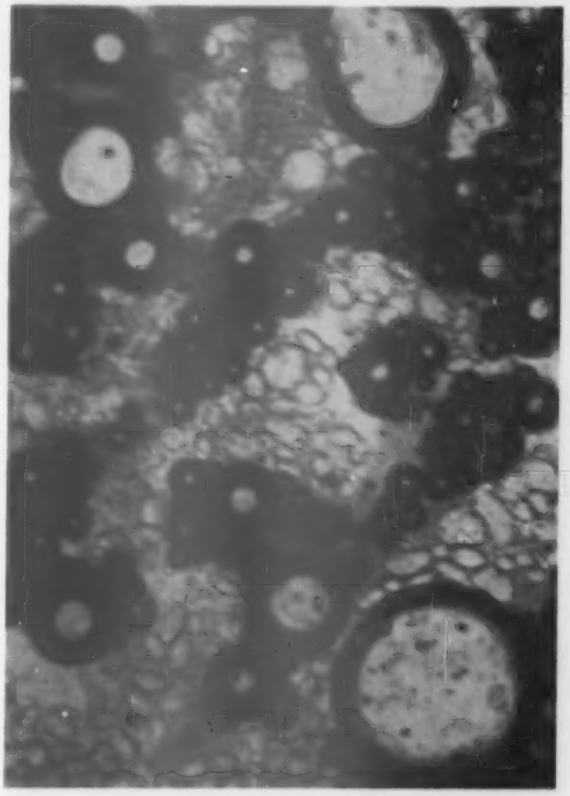

Figure 4. Fat distribution in cake batter made with conventional churn butter, no added emulsifying agent (c. 190 ×).

contained added mono- and diglyceride than without the emulsifier. Other investigators have reported similar findings *(4, 7)*.

Microscopic slides of the finished cakes indicated similarities in fat distribution within the cellular structure of cakes made with conventional churn and with continuous process butters with no added emulsifying agent, as shown in Figures 8 and 9. The fat appeared to be irregularly distributed and largely within the cell walls. On the other hand, the use of emulsifying agent in either kind of butter resulted in a fine and even distribution of fat and of air cells within the cake (Figures 10 and 11).

The histological method of investigation used in this problem shows promise for wider application in studies of the location of particular ingredients within flour mixtures. Staining techniques suited to the differentiation of specific ingredients could be applied to various kinds of cake and related foods.

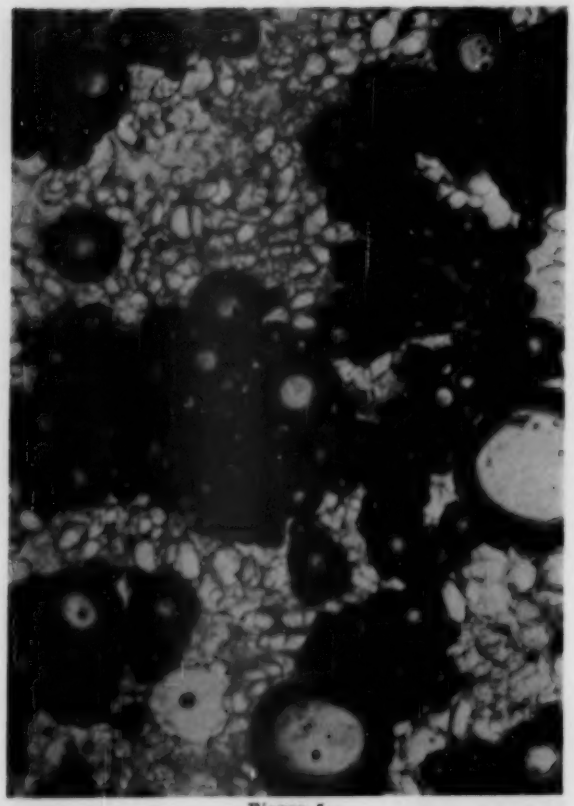

Figure 5

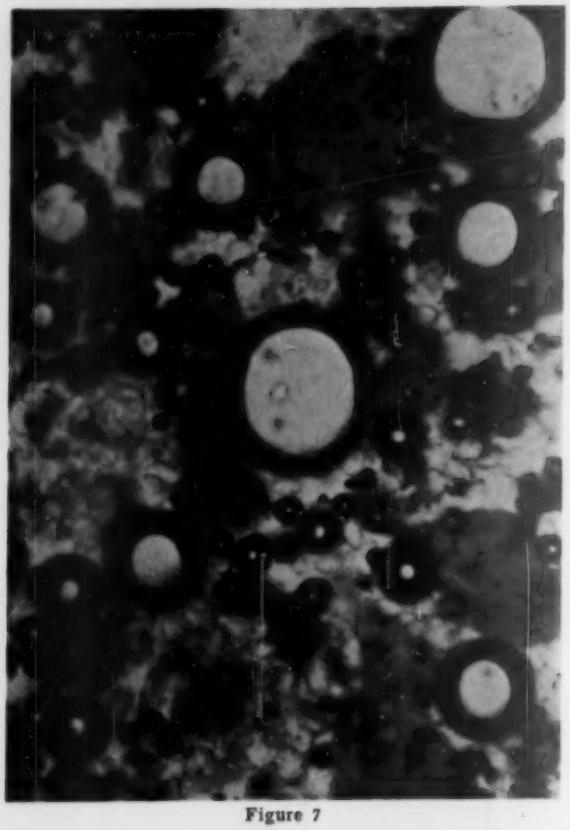

Figure 7

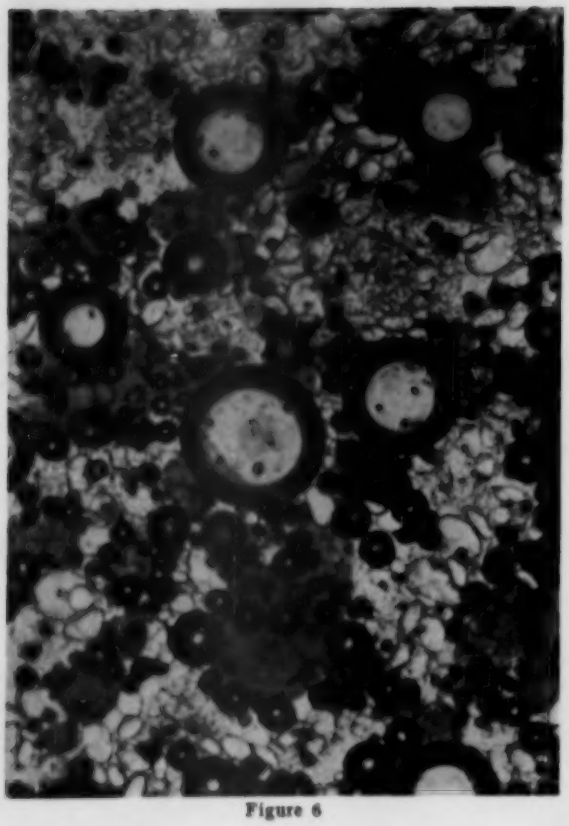

Figure 6

Figure 8

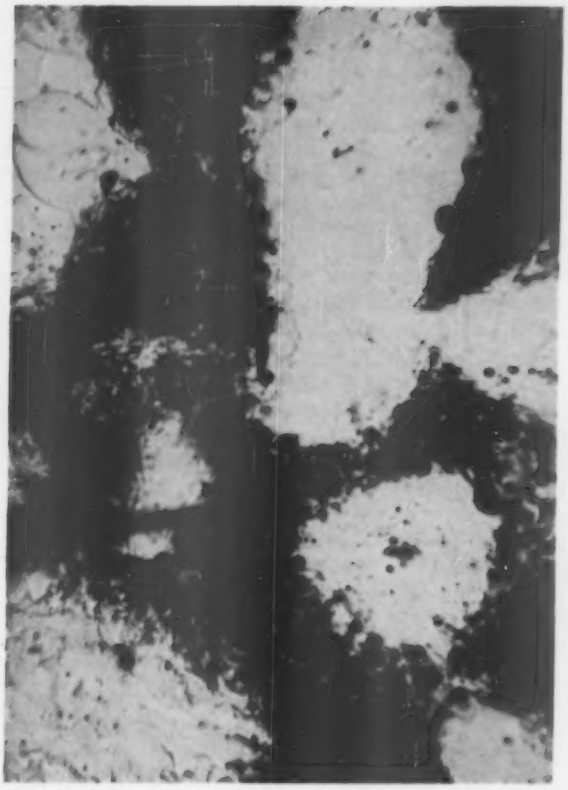

Figure 9

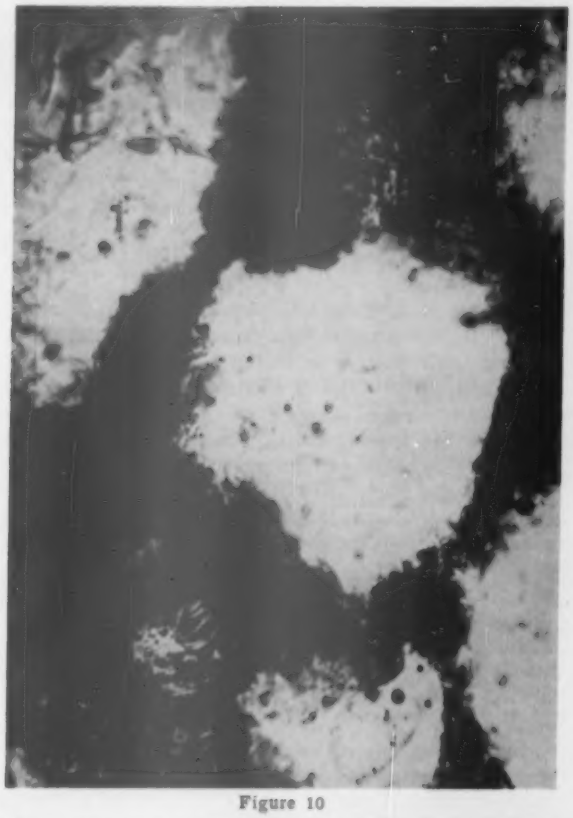

Figure 10

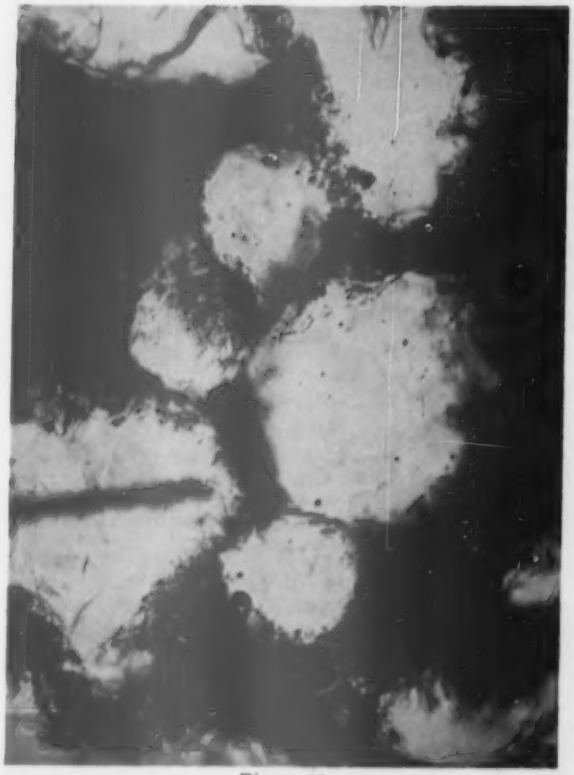

Figure 11

Figure 5. Fat distribution in cake batter made with continuous process butter, no added emulsifying agent (c. 190 ×).

Figure 6. Fat distribution in cake batter made with conventional churn butter containing 3.5 percent added emulsifier (c. 190 ×).

Figure 7. Fat distribution in cake batter made with continuous process butter containing 3.5 percent added emulsifier (c. 190 ×).

Figure 8. Fat distribution in cake made with conventional churn butter, no added emulsifying agent (c. 98 ×).

Figure 9. Fat distribution in cake made with continuous process butter, no added emulsifying agent (c. 98 ×).

Figure 10. Fat distribution in cake made with conventional churn butter containing 3.5 percent added emulsifying agent (c. 98 ×).

Figure 11. Fat distribution in plain cake made with continuous process butter containing 3.5 percent added emulsifying agent (c. 98 ×).

SUMMARY AND CONCLUSIONS

Samples of butter of the same quality (92 score), but manufactured by two different methods, conventional churn and continuous process, were used with and without added emulsifying agent to determine the effects on physical properties of plain cake. The liquid emulsifying agent, incorporated in the butters at a 3.5% level, was of a mono- and diglyceride type and of vegetable origin. The cakes were made according to a medium-sugar formula and a modified flour-batter method of mixing.

Little or no difference in physical properties associated with the method of manufacture for the butter was evident in the batters or in the baked cakes. Batters made with either type of butter containing no added emulsifier were well aerated and relatively viscous, but had a curdled appearance. Addition of the emulsifying agent to either kind of butter resulted in batters which were smooth, runny, and had a higher specific gravity (indicating less incorporated air) than did batters prepared from the butter containing no added emulsifier. No differences in weight loss during baking were associated with the use of either kind of butter or with the addition of emulsifier. Volume of cakes, as indicated by area of cross sections, appeared to be little affected by the kind of butter, but to be slightly improved with the addition of emulsifying agent to either kind of butter.

In batters prepared from either type of butter without added emulsifier, examination by a histological method indicated that the fat was distributed in clumps with air bubbles occluded in these areas only. On the other hand, in batters prepared with either type of butter with added emulsifier the fat was well distributed throughout the batter; interfaces between fat areas and the aqueous phase were indistinctly defined; and air bubbles were dispersed throughout the batters and were somewhat indefinitely associated with the fat areas.

Differences in fat distribution, as revealed by microscopic examination of slides, were more obvious in the batters than in the finished cake when effects of emulsified and unemulsified butters were compared. The stained fat in the sections of cake made without emulsifier added to the butter appeared irregularly scattered within the cellular structure and covered only parts of the air-cake interface. Addition of the emulsifying agent to either kind of butter resulted in uniform distribution of the fat throughout the cake.

In conclusion, butter manufactured by the continuous process appeared to be as effective a shortening agent for plain cake as was butter made by the conventional churn method. Addition of a mono- and diglyceride type of emulsifying agent to either kind of butter aided in dispersion of fat and of gas cells throughout the batter and resulted in a more even fat distribution in finished cake than when butter was used which contained no added emulsifier.

Acknowledgments

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LITERATURE CITED

1. Bailey, A. E. *Industrial Oil and Fat Products.* 1945, Interscience Publishers, Inc., New York, N. Y.
2. Bailey, A. E., and McKinney, R. H. A rational method for evaluating the creaming qualities of a shortening. *Oil and Soap,* **18**, 120-122 (1941).
3. Billig, E. T. Baking qualities of butter as affected by the manufacturing process and the addition of an emulsifying agent. (M.S. thesis, The Ohio State University, 1953.)
4. Carlin, G. T. A microscopic study of the behavior of fats in cake batters. *Cereal Chem.,* **21**, 189-199 (1944).
5. Harris, B. R., Epstein, A. K., and Cahn, F. J. Fatty interface modifiers. Composition, properties, and uses in the food industries. *Oil and Soap,* **18**, 179-182 (1941).
6. Jacobs, M. B. *Food and Food Products.* 1947, Interscience Publishers, Inc., New York, N. Y.
7. Jooste, M. E., and Mackey, A. O. Cake structure and palatability as affected by emulsifying agents and baking temperatures. *Food Research,* **17**, 185-196 (1952).
8. Pratt, C. D. Certain partial ester emulsifier levels in food. *Food Technol.,* **6**, 425-431 (1952).
9. Pratt, C. D., and Hays, W. W. Food emulsifiers bring new highs in uniformity. *Food Eng.,* **24**, 109-112 (1952).
10. Pyler, E. J. *Baking Science and Technology.* Vol. I, 1952, Siebel Publishing Company, Chicago, Ill.
11. Wilster, G. H. *Practical Butter Manufacture.* 6th Ed., 1948, OSC Cooperative Association, Corvallis, Oregon.

Problems in Developing and Administering a State Food and Drug Regulatory Program[a]

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During the past forty years my time has been devoted to solving and resolving regulatory problems in the food and drug field in the interest of protecting the consumer. Throughout this period, I have been aware of the invaluable service rendered by Food Technologist in providing the American consumer with food of the highest quality ever achieved in history. But more than ever before there is a need for a better understanding of problems and objectives common to all who are concerned with food. It is my sincere belief (and my long association in this field confirms this view) that we are entering a period where close collaboration between industry and government can be of greater benefit to public service than in any previous era. In fact, close collaboration is imperative if we are to avoid cross-purposes, which can only work to the detriment of consumer interests.

The public frequently takes the work of the Bureau of Food and Drug Inspections pretty much for granted. In a general way they believe that protective laws have been enacted, are enforced, and that the products on the shelves can be consumed with confidence. You, particularly, can fully appreciate that these accomplishments do not occur by chance. As brilliant research, technology, and effort underlie the marketing of many of your products so, too, does a similar effort underlie the development of a food and drug regulatory program. Ceaseless attention to details—large and small—is required in both instances.

Consider, for example, the problem of transportation of frozen food. The important role this industry plays in supplying us with wholesome, top quality foods the year round is impaired if the problem of distribution is not fully met. Repeated complaints of frozen foods purchased at the retail level reveal that quality deterioration does occur between the packer and consumer. Our observations indicate that faulty transportation methods during short hauls, poor practices in storage at the retail level, and, of course, the consumer himself is largely responsible for this situation. The industry has a safe, commendable record of food processing. Though no demonstrable health hazard has so far been shown, there is no reason to be complacent.

With the advent of packaging of low-acid frozen foods in hermetically sealed containers, we are confronted with the possibility of a recurrence of the need which gave rise to our control of canned low-acid foods sterilized by conventional heat treatment. Some background information on the measures taken to effect control of this situation will be of interest.

CANNERY INSPECTION

The Cannery Inspection Act provides for the licensing of premises packing non-acid foods in hermetically sealed containers. It established an excellent control system to ensure proper time and temperature cooks for such products. The Cannery Inspection Section is a specialized section of the Bureau of Food and Drug Inspections whose primary function is the enforcement of the Cannery Inspection Act and the State Board of Health regulations relative to cannery and food and drug inspections. The Act became law in 1925 after a series of 22 botulism poisoning outbreaks between 1919 and 1925 affecting 131 people, causing 58 deaths, and involving commercially canned California products. The entire canning industry of California was in serious jeopardy until the enactment of the Cannery Inspection Act, the start of daily cannery inspection, and the adoption of regulations governing the heat treatment of low-acid canned foods.

It was through the efforts of Mr. Robert I. Bently, deceased, President of the California Packing Corporation, that this systematic inspection service was developed in California. It was during this time that the services of Dr. Karl F. Meyer of the George Williams Hooper Foundation for Medical Research, University of California, were obtained by the canning industry. His assignment was to conduct research and formulate controls for the prevention of botulism. During the last thirty years, the two laboratories maintained by the Cannery Inspection Section and under his direction as Chief Consultant to the State Department of Public Health have developed procedures and processes which have become standard. They have been adopted and used throughout the United States and many other countries.

Cannery Inspection has been instrumental in raising the quality and safety of California canned products to the highest in the United States; this fact, generally recognized by the trade, research institutions, and educators throughout the world, is evidenced by continuous inquiries from all over the world for information regarding cannery inspection work in California. The success of the Cannery Inspection work has been due in no small part to the whole-hearted cooperation of the canning industry; it is an outstanding example of cooperative effort between industry and Government.

It is significant to note that there have been no outbreaks of botulism in commercially canned California products since the inception of daily cannery inspection in 1925. However, since we have about one thousand miles of coast line, our fish canneries, for example, are scattered from Eureka to San Diego. It is necessary for us to provide inspectors at a moment's notice to supervise canning procedures. Add to this the fact that there is constant fluctuation and availability of raw materials. Thus, until recently, Monterey was an important center of our sardine industry, requiring our services; today, sardines have disappeared from the California coast.

Partnership Must Be the Objective

This leads us, quite naturally, to a consideration of our own inherent administrative problem. The field personnel in our Food and Drug Section is small—as governmental agencies go; they

[a] Presented at the Fourteenth Annual Meeting of the Institute of Food Technologists, Los Angeles, California, June 29, 1954.

are maintained at a cost of about two cents annually per taxpayer. The prerequisites for our work are exacting and of such a nature that difficulty in recruitment has been experienced. This has resulted in a shortage of qualified personnel; actually we are below the allotted complement.

Though the United States Food and Drug Administration has always rendered us valuable assistance, it is becoming increasingly evident that we must assume an even larger share of the responsibility for marketing foods and drugs in California at our accustomed high level.

It must be at once apparent to you that partnership must be the objective and ultimate goal for all who contribute to the betterment of public health. Since the success of all public health efforts must, of necessity, be predicated on the effective application of our basic food and drug laws, it is imperative that we establish more effective liaison. It is of the greatest importance, particularly in view of the troublesome, uncertain time in which we live, that you continue to exert maximum voluntary compliance.

There are strong and compelling reasons for seeking your cooperation and active support. Not the least of these is the urgent necessity to improve our "united action" so as to serve the public more effectively.

Moreover, besides acing as an agency for the protection of the consumer, the Bureau can be considered as a great equalizer in the food and drug industry—protecting the large responsible segment of industry against the unscrupulous competion of the slovenly, the inept, and the chiseler, who, in order to undersell, would cut quality, contents, or potency. The problem created by sharpening competition may lead some to omit valuable ingredients, use inferior raw materials, or neglect the rudiments of safe, sanitary practices.

The Bureau will continue to devote its efforts to assure that the people of the state (and the many who consume California-made products) receive a dependable supply of wholesome, pure foods and safe, efficacious drugs.

Traditionally, in order to attain this objective, the Bureau operates in a dual category:

(1) A regulatory agency, enforcing food and drug laws and regulatory standards adopted by the State Board of Public Health;

(2) A consultative agency which meets with industry to discuss problems related to labeling, advertising, and production of foods or drugs.

Such discussions may be formal through such salutary meetings as this, or more importantly—from the standpoint of service—through our day-to-day conferences with manufacturers.

While the law makes no provisions for this activity, nor places an obligation on us to provide such consultive service, we are firmly convinced that preventive rather than punitive measures should prevail. This coincides quite fundamentally with the entire philosophy of public health.

At this point, I wish to pay just tribute and recognition to responsible leaders of industry who, through their loyal support, have been highly instrumental in laying the foundation for our present achievements. In consequence, we have in California today model and uniform laws governing this field which stand as a bulwark for the protection of public health and welfare. The importance of these dynamic laws—which so profoundly affect the economy, happiness and well-being of all our people—cannot be over-emphasized.

The regulations adopted thereunder are no less important. The growing complexities of food and drug administration brought about, paradoxically enough, in many instances by technological advances you have developed require a greater penetration into the problems of industry and consumer needs.

"A Standardised Food Must Conform to Standards"

In meeting this challenge we must rely on sound governmental policies—policies which are clearly defined and which spell out requirements and responsibilities. To a large extent our regulations do this. They do not discourage growth, expansion, or scientific research.

Permit me to cite a case in point:

We have currently received a number of inquiries relating to the conformity of a food product to one for which a standard has been established: For the past several years the tomato industry has functioned successfully with strict regard to established standards. Recently, certain equipment has been developed possessing technical advantages. It reduces tomato products to such an extent as to increase the viscosity and yield; however, it is possible that skins or seeds are likewise included, and may not be removed by the finisher. Tomato paste conforming to standards must have skins and seeds removed. Though the public consumes whole tomatoes with skins and seeds intact, a comminuted product made with skins and seeds, even though labeled "Made from Whole Tomatoes," would deviate from standards and would be considered misbranded. A dilemma could be created because of our insistence on strict compliance with standards.

Important Federal court decisions involving imitation jam and a frozen dessert (an unstandardized product) have led us to the following interpretation:

(1) Products which are standardized must conform strictly to the standard specified;

(2) Products that resemble standardized products must be labeled "imitation."

Neither decision disposes of the question which arises when a food resembling a standardized product and not labeled "imitation" legally departs from the standard but is not sold under the name of the standardized food and is otherwise honestly labeled and marketed.

The court has answered this question for unstandardized food. It is reasonable to suppose that a similar verdict would be reached for a standardized product.

The problem may be summarized by stating that a standardized food must conform to standards. Obvious imitations of standardized and customary standardized foods must be labeled imitations. It is when a product enters the fringe area of ambiguity created by the phrase "customary standard" that we are confronted with conflicting problems.

Regulating the Advertising of Foods and Drugs

An important phase of our work consists of regulating the advertising of foods and drugs. At the national level this function is controlled by two agencies. The Federal Trade Commission regulates the general mediums of advertising, while the Food and Drug Administration regulates advertising material in label, pamphlets, leaflets, or brochures accompanying the article.

As you know, advertising is the mainstay of modern merchandising, and we are fully aware that the merchandiser is entitled to some "puffing" in order to attract customers in this highly competitive field. However, food advertising must be considered from the point of view of both the public and the vendor. Truthful advertising serves the interest of both, whereas deceitful advertising can severely injure the entire industry by destroying public confidence. Facts should be stated so as to avoid misinterpretation or misunderstanding. Appropriate explanations, or pertinent information should accompany scientific statements whenever necessary to ensure correct interpretation.

The writer or sponsor of advertising should make certain that

(1) Claims are stated simply enough to be thoroughly and properly understood by the average consumer under usual conditions of purchase.

(2) Claims are kept within the realms of probability, avoiding exaggeration or implication that all nutritional values reside in a single food, or placing undue emphasis on the nutritional or physiological values of any one food or implying that the food provides any inherent mysterious health values—a food is a food and not a drug!

(3) Claims can be substantiated by adequate evidence.

Objectionable Claims

There are many instances of objectionable claims which we have encountered. Recently, the baking industry has employed the phrase, "Low Calorie—High Protein." It is our belief that the baking industry as a whole does not subscribe to this manner of advertising.

If one substitutes protein for carbohydrates there is no significant change in the caloric value. The proteins of bread—whether white, whole wheat or rye—constitute from 8 to 12% of the total weight on the basis of about 38% moisture. Though protein content is not significant in one ounce, when bread is regularly consumed in normal amounts (a quarter pound or more per day), it supplies about one-tenth of the adult daily protein requirement. As a source of calories bread is one of the most economical staples in the diet. Its low cost, flavor and digestibility ensures its permanent place in the American diet.

It is unfortunate that many people are undertaking programs of weight-reduction by means of dietary restrictions without the advice of a competent physician. This slogan has focused attention on bread; and, in consequence, many persons have eliminated bread from reducing diets.

Nutritional knowledge indicates that when a reduction in calories is to be made one should diminish consumption of foods which supply relatively large proportions of calories in comparison with minerals and vitamins. By inference, standardized enriched bread can be used to better advantage for reducing purposes than many so-called "Low Calorie—High Protein" breads.

With the advent of television our efforts to keep the advertising truthful in statement and by implication have increased many fold.

The American trend to reduce has brought a corollary problem. Artificial substitutes for ordinary foods have flooded the market as "Dietetic Foods." Lay advertising for these special foods intended for weight control and disease management should not indicate directly or indirectly that they are curative, or increase the ability of the body to utilize sugar, or give the erroneous impression that the food taken in restricted quantities has reducing action.

We strongly feel that such special foods should be clearly distinguished by labeling, advertising, and method of sale from normal wholesome foods. It is difficult to estimate the possible effect of prolonged consumption by children of these non-nutritive substances.

On the other hand, we have actively sponsored the use of fluoridated waters. The tangible demonstrated benefits that can be derived by children consuming waters containing up to 1 p.p.m. fluorides far exceeds the calculated risk involved when prepared under adequate controls.

Similarly, no restrictions have been indicated for salt-free items other than to insist on informative labeling in accordance with the findings of specialists, which, in turn, are reflected by recently amended regulations. It is estimated that the average individual consumes one teaspoonful (5,000 mg.) of sodium daily. One on a restricted diet may be limited to 300 mg. Since there are no foods, not even drinking water, completely free of sodium, it becomes difficult to provide a daily diet containing such a small amount. Hence, it becomes a matter of serious consequence for such a person to be able to estimate with accuracy his daily consumption of sodium.

Exploitation of Vitamins and Minerals

Closely related to this entire problem is the exploitation of vitamins and minerals by promotional schemes of a dubious nature. Often vague or non-specific claims are made which imply the presence of all nutritionally valuable mineral and vitamin elements in physiologically significant quantities in foods. Such vague statements are not properly informative, if not actually misleading and deceptive. This promotes faulty advertising practices; whereas, advertising should correctly and explicitly inform the public.

Mineral claims should stipulate the individual element or elements intended for attention. Elements not present in nutritionally significant amounts in a food and in the quantity of the food likely to be consumed in the diet do not warrant mention. Mineral claims should name those elements only which are contributed in substantial physiologic amounts by the respective foods in the quantities ordinarily consumed in the diet.

Vitamin claims should stipulate the specific vitamin or vitamins present. Vitamins present in a food in insufficient quantity to contribute in any significant manner to the respective vitamin values of the diet do not warrant mention. It is desirable that warranted vitamin claims be expressed in appropriate terms indicative of the relative potency of the food as a source of the vitamins in the dietary schedule.

The labels and advertising shall contain a statement listing all the minerals and vitamin ingredients of nutritional significance in the order of decreasing predominance by weight, and shall indicate the special purpose for which the product is intended ("food supplement"). These statements, so far as is practical, should be in close proximity to the trade name. In addition, such information should be given as is significant to permit the intelligent use of the particular product by the consumer. This includes, of course, minimum daily requirements expressed in terms of international units or U. S. P. units, etc. It is also important for food manufacturers to perform assays of the vitamin potency on samples of food products which have been kept under conditions of storage comparable to those to which the food product is likely to be subjected.

Exaggerated Therapeutic Claims

Particularly vexing to us is the surreptitious means and exaggerated therapeutic claims employed by many distributors of otherwise acceptable products. Misrepresentations of this type by door-to-door canvassers and salesmen are difficult to control; they are excessively time-consuming and require prearranged meetings in the homes of prospective victims and a permanent recording of the violative pitch employed by the salesmen. Daily we encounter worthless devices offered as cure-alls for serious diseases, for fantastic prices—up to $10,000 each.

Our actions on devices of this nature have been numerous; moreover, they constitute our most difficult cases. Many who need competent medical attention become victimized by quacks with worthless nostrums and devices. Almost without exception the victims believe that the Bureau is working against their best interests and for the "medical trust." This concept has become so inured in the minds of many, that some so-called health lecturers precede their harangue with the statement, "Both Federal and State Food and Drug have tried to put me out of business, but they will never succeed."

The magnitude of the problem is illustrated by the strenuous effort required to conclude one of our recent cases.

Patiently, Bureau agents gathered evidence against four individuals promoting a Calozone generator—a simple device which created ozone in dangerous concentrations. Mounting evidence convinced us that the elaborate promotional scheme, which had resulted in several thousand sales at $150 each, constituted a conspiracy to defeat the purposes of the Pure Drugs Act. Our conclusive proof led the four to plead guilty; and on May 26, they received substantial sentences of up to a year in jail and $2500 payment as restitution.

. . . "TO MAINTAIN PURITY IN FOODS . . ."

The paramount function of the Bureau is to maintain purity in foods. We have always been skeptical of new, untried food substitutes. This does not mean that we have been unprogressive. On the contrary, we have felt that genuine progress comes faster if haste is made slowly!

We believe this reflects the attitude of the public which has a vital stake in the problem of chemical additives to foods. New emulsifiers, stabilizers, and preservatives are being continually proposed. Such products are often used without acquiring adequate information

relating to acute or chronic toxicity, or the effects on nutrition that such substances may impart to foods. Sensational and misleading articles and information have aroused public distrust in the integrity of our food supply.

There is an urgent need for the development of standards which will limit or prevent the use of untried or dangerous chemical additives whose safety has not been evaluated and for which a need for their use has not been clearly demonstrated.

There will be increased use of insecticides, fungicides and weedicides if raw fruits and vegetables are to be produced and stored in sufficient quantity to meet growing demand.

In an effort to prevent insect contamination of stored foods, greater reliance is placed on control with insecticides and rodenticides. We have found dangerous rodenticides such as 1080, strychnine-impregnated grain, etc., in close proximity to food handling areas, despite regulations prohibiting their use in areas where food is exposed.

Producers are employing hormonal agents such as diethylstilbesterol to fatten poultry. The slaughter of such poultry before the lapse of recommended time after injection creates a potential hazard to the consumer through ingestion of unabsorbed or accumulated potent hormones.

This whole subject is undergoing a re-examination because of recent findings on established compounds having a history of long usage. The findings with respect to such familiar substances as nitrogen trichloride, coumarin, sodium benzoate, F. D. C. Orange No. 1, and No. 2, as well as other related coal-tar derivatives has focused more scrutiny on the entire problem. The industry is to be commended for the voluntary action taken in removing several of these from the market.

Moreover, significant strides in the utilization of radioactive wastes for food processing will make it essential that proper monitoring, personnel protection, production supervision, disposal, and distribution of such products are conducted in such a manner as to limit inherent hazards.

Space does not permit a consideration of such problems as:

The development of better methods for handling and distributing fresh fish and shellfish.

The use of contaminated raw water for preliminary food processing operations.

The evaluation of the increasing evidence that Salmonella infections exist in poultry and egg products.

However, I must call attention to the continual battle that must be waged in the name of sanitation. Though much improvement in the sanitation of food producing and storing establishments has occurred, I cannot emphasize too strongly the obligation you have to produce food under clean, sanitary conditions. Particular care must be exercised by firms which, due to the nature of their operations, involving high humidity, heat, and media suitable for mold and bacterial growth, are most vulnerable to insanitation.

Currently we are making considerable progress in the improvement of the sanitary level for fruit drying yards. This program is complicated somewhat by the fact that numerous growers are engaged in this activity with little or no conception of sanitary principles. It will require joint educational efforts with agencies such as the Farm Bureau to promote a desire to protect the product against the depredation from rodents, insects, mold, barnyard domestic animals, wildlife, and windblown contamination. However, in the interim, there can be no relaxation of effort in this regard. Anything short of the most meticulous sanitary care in preparation, processing, and storing of food will put such a person in a dangerous and indefensible position.

Sanitation problems are manifold and often of considerable complexity. By the same token unlimited opportunities are available for those in Government and in industry to accept and solve these problems in the best interest of public health.

Pen Surfaces and Odour Development in Trawler Fish Holds

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Various surfaces against which Atlantic groundfish were stowed aboard ship and in the laboratory were observed for their effect on the preservation of the catch. All fish taken from heavily contaminated wood surfaces carried vile-smelling, bilgy odours. No benefit was derived from washing these boards prior to stowage. Almost all fish in contact with painted and varnished wood and aluminum alloy surfaces, which were the best of the others tested, were free from bilgy and sour odours. Wood surfaces cannot be maintained intact in a fish hold, hence aluminum alloys or other corrosion-resistant, non-toxic metals such as Monel and nickel-steel are a good choice for all difficult-to-ice vertical surfaces of a fish pen. Metal screens which hold the fish off contaminated wood surfaces and at the same time retain crushed ice between the screens and these surfaces, provide an alternative construction method.

The purpose of this investigation was to learn the effect of various types of surfaces which may come in contact with the fish on the preservation of the catch; and to determine if hold linings impermeable to bacteria, e.g. metal surfaces, are necessary for the proper stowage of groundfish aboard Atlantic Coast trawlers.

The bacterial flora which cause deterioration in fish stowed at sea consist predominantly of psychrophilic organisms derived mainly from fish slime and feces. A large proportion of these organisms are facultative anaerobes. In the absence of air some species produce very strong fecal odours suggestive of bilge water, and fish developing this type of spoilage are referred to by the trade as "bilgy" fish *(4)*. Under conditions where atmospheric oxygen is available, these same species or other organisms produce various types of sour, turnipy, or putrid odours *(9, 10)*. Unpainted, porous, slime-soaked wood pen boards carry an extremely heavy bacterial load. When fish are pressed against them so that air cannot reach these areas, the slime becomes the breeding ground of large numbers of organisms, some species of which will produce fecal odours in the fish. On the other hand, well-preserved, close-textured materials do not carry heavy bacterial loads prior to the stowage of the fish. One would expect that spoilage, if it were to occur at all in fish stowed against such surfaces, would be caused for the most part by organisms carried in the slime and gills of the fish at the time of gutting, rather than in the boards. And while the presence or absence of air at the surfaces of these boards would control the type of spoilage which might develop in these perimeter-stowed fish, it would seem probable that a true anaerobic environment would be less likely to occur under these conditions than under those established when fish are pressed against slime-soaked surfaces.

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EXPERIMENTAL PROCEDURES

Types and conditions of surfaces under test aboard ship. The surfaces tested on pen bottoms and in vertical positions are shown in Tables 1 and 2 respectively. Washing procedures adopted or other treatment of the boards prior to their use, are given in the footnotes to the tables.

The surfaces to be tested were placed on the bottoms and against the pen bulkheads, commonly called the "wings," of two fish pens in a trawler fishing out of Halifax. These surfaces, each of an area of about 7 square feet, were compared with the wood surfaces of the fish hold itself: the pen back walls which form the side wall of the boat, and the pen boards or division boards which measure about 200 square feet in area for each pen.

Stowage of fish aboard ship. For 5 fishing trips, no ice was placed between the cod or haddock being stowed and the surfaces under test, thus ensuring that the fish were stowed in contact with these surfaces. Crushed ice in the ratio by weight of about 1 part ice to 2 parts fish was used to surround those parts of the fish not in contact with the surfaces being investigated. This ensured that the fish were chilled quickly and remained cool for the duration of the trip. Ice was mixed among all other fish stowed in the pens in the same ratio. The length of the fishing trip determined the length of time the fish were in contact with the surfaces. For the most part, the fish from the first day's catch were stowed in the test pens.

Examination of fish after landing. Upon discharge of the catch after each trip, representative samples were withdrawn from those fish in contact with the surfaces under test. Control fish, surrounded by ice, in the centre of the pen were also taken. All samples were examined for general appearance and odour upon being removed from the pens, and were re-examined soon after at the laboratory where they were filleted, skinned, and the skinned surfaces of the fillets examined for odour. The fillets were judged for marketability on the basis of appearance and odour. The fish were classified (a) *definitely bilgy* (b) *definitely sour* (c) *possessing mild off-odours* (possibly bilgy odours) and (d) *fish free of spoilage odours*. The author and another trained staff member carried out the examinations of samples from the 5 trips.

Stowage of fish in the laboratory. Experiments were also conducted in the laboratory since this permitted stowage against boards contaminated to different degrees, and removal of the fish from the boards after any desired period of stowage.

Two of three contaminated wood pen boards taken from a fish hold were brushed and washed in warm tap water and one board was then sterilized by exposure for 1 hour to steam at 15 p.s.i.g. The fish slime was left on the third board. The outside surfaces of 9 odour-free, gutted, unfilleted fish that had been 3 days on ice were given 3 brushings under running tap water, and the fish were then rinsed, both in the gut cavity and on the outside under running tap water, to ensure that the bacterial load carried on the fish would be uniformly minimal. Three fish were laid on each board and the boards were then placed on a bed of ice about 1 foot in depth within a painted spruce box, from which the melting ice water could escape. The fish were covered with crushed ice to a depth of about 1 foot. The box was stored at room temperature. One fish from each board was examined 2 and 7 days later, respectively.

To assess the effectiveness of the commercial procedure of brushing and washing the boards after each trip, the board of the previous experiment which had been washed but not steam sterilized was washed again, and tested as above. The process of stowing more fresh fish on the same board, which in each case was re-washed prior to being used, was repeated twice.

TABLE 1

Development of bilgy odours in fish stowed in contact with horizontal surfaces located in the bottom of fish pens [1, 2]

Type of surface	Species and class of fish	Elapsed time fish in stowage (days)	Definite bilgy odours on fish	Definite bilgy odours on fillets	Mild off-odours, possibly bilgy	Marketability of fillets
Contaminated spruce boards that had been used previously in trawler holds	Scrod and market cod	7	yes	yes	.....	no
	Steak cod	7	yes	yes	.....	no
Freshly planed and unpainted spruce boards	Scrod and market cod	7	yes	yes	.....	no
	Steak cod (1)	10	no	no	no	yes
	(2)	7	yes	yes	.....	no
	Large haddock	7	yes	yes	.....	no
Freshly planed and painted spruce boards	Scrod and market cod	7	no	no	no	yes
	Steak cod	7	no	no	no	yes
		10	no	no	no	yes
	Large haddock	7	yes	yes	.....	no
Unpainted recently set Portland cement	Steak cod (1)	10	no	no	no	yes
	(2)	7	yes	yes	.....	no
	Large haddock	7	yes	yes	.....	no
Transparent plastic	Steak cod	7	no	no	no	yes
		10	no	no	no	yes
	Large haddock	7	yes	yes	.....	no
Aluminum alloy sheet	Steak cod	7	no	no	no	yes
		10	no	no	no	yes
	Large haddock	7	no	no	no	yes

[1] All data apply to samples which were taken from surfaces which had been brushed and washed with clean hot tap water prior to ship's departure for the fishing grounds.

[2] Where there were variations in the quality of samples drawn from similar surfaces, those samples given the higher rating are scored opposite the bracketed numeral one, i.e. (1), appearing in Column 2; and those given the lower rating are scored opposite the bracketed numeral two, i.e. (2).

TABLE 2

Development of bilgy odours in fish stowed in contact with vertical surfaces located on the walls of fish pens [1, 2, 3]

Type of surface	Species and class of fish	Elapsed time fish in stowage (days)	Definite bilgy odours on fish	Definite bilgy odours on fillets	Mild off-odours, possibly bilgy	Marketability of fillets
Contaminated spruce boards that had been used previously in trawler holds	Scrod and market cod	7*	yes	yes	.....	no
		8*	yes	yes	.....	no
	Steak cod	4*	yes	yes	.....	no
		7*	yes	yes	.....	no
		10	yes	yes	.....	no
	Large haddock	7*	yes	yes	.....	no
		7	yes	yes	.....	no
	Small haddock	8	yes	yes	.....	no
Boards from same lot as above, but steam sterilized prior to test	Large haddock	7	no	no	no	yes
Freshly planed and painted spruce boards	Steak cod	10	no	no	no	yes
Freshly planed and varnished spruce boards	Steak cod	10	no	no	no	yes
Aluminum alloy sheet	Market cod	8	no	no	no	yes
	Steak cod	10	no	no	no	yes
	Large haddock (1)	7	no	no	no	yes
	(2)	7	no	no	yes	yes
	Small haddock	8	no	no	no	yes
Corrugated aluminum alloy pen boards (corrugations vertical)	Market cod	8	no	no	no	yes
	Large haddock (1)	7	no	no	no	yes
	(2)	7	no	no	yes	yes
	Small haddock (1)	8	no	no	no	yes
	(2)	8	no	no	yes	yes
Corrugated aluminum alloy pen boards (corrugations horizontal)	Market cod	8	no	no	no	yes
	Large haddock	7	no	no	yes	yes

[1] All data without the asterisks, with one exception, apply to samples which were taken from surfaces which had been washed with clean hot tap water prior to the ship's departure for the fishing grounds. The exception applies to the boards which were steam sterilized after being washed in the above mentioned way.

[2] All data accompanying the asterisks apply to samples taken from surfaces which had been washed with harbour water (hot) prior to the ship's departure.

[3] Where there were variations in the quality of samples drawn from similar surfaces, those samples given the higher rating are scored opposite the bracketed numeral one, i.e. (1) appearing in column 2; and those given the lower rating are scored opposite the bracketed numeral two, i.e. (2).

RESULTS

The results show a marked difference in keeping time of fish stowed against heavily contaminated wood surfaces from fish stowed against all other surfaces (Tables 1 and 2). All fish stowed against the former became bilgy. Fish in contact with the unpainted wood previously steam sterilized, showed no bilgy odours in the stowage period. Almost all fish in contact with painted and varnished wood and aluminum surfaces, which were the best of the other surfaces tested, were free from bilgy odours.

There was no benefit derived from our method of washing worn wood boards between trips. The same washing procedure proved effective in almost all cases when used with aluminum alloy and painted wood surfaces.

Bilginess appeared to be equally strong in fish stowed against vertically disposed worn wood boards at the top and at the bottom of the wings and in those stowed against horizontally disposed boards of similar type, size, and shape located at the bottom of the pen where the fish are under considerable pressure.

All well-iced fish not in contact with pen boundaries were free from bilgy and sour odours.

Sour odours were found in a few fish in contact with all the surfaces tested. These odours were detected only when those of the bilgy type were absent or slight.

The results of the laboratory experiment on fish stowed against wood boards were: (a) bilgy odours were observed in fish lying against the washed board and the slimy board, 2 days after the fish had been stowed; (b) examination of fillets cut from these fish showed that the vilest odours were associated with fish that had been in contact with the washed board; (c) no bilgy odours had developed in fish against the sterile board up to a period of 7 days, at which time the test was terminated; (d) deslimed fish which were later stowed against a previously contaminated and then washed board, developed bilgy odours during each of 3 successive tests after being in contact with the board for 2 days only.

DISCUSSION

In the Nova Scotian and Newfoundland Banks fishery, spoilage of the bilgy type may be expected in fish stowed in contact with washed, rough-surfaced, slime-soaked wood boards as early as 4 days after stowage, while similar spoilage may be found infrequently in fish in stowage for 7 and 8 days and more against washed, well-painted wood boards and aluminum alloy surfaces. Sourness may occur in fish in contact with well preserved surfaces but this should not be a serious factor aboard a trawler where a reasonable amount of care is taken with the icing.

The pronounced difference in the keeping time of fish in contact with worn wood in contrast to metal, suggests that wood holds, despite low first cost, may be very expensive. Metals, for use in all difficult-to-ice sections of the fish pen, e.g. all vertical walls, should be a good investment. Well-painted wood boards may give equally good results at first, but it is impossible to keep them in first-class condition when they are subject to heavy wear and tear. Ultimately, many of these boards carry heavy bacterial loads.

Two trawlers with holds properly insulated, properly refrigerated, and completely lined with aluminum are in operation out of fishing ports on the Canadian Atlantic coast *(7)*. Although the data which have been collected are not adequate to determine precisely the difference in keeping time between fish stowed in this type of hold and in the conventional hold, the available information is in general agreement with the results obtained in this work. We wish to make reference also to other publications describing the use in fish holds of aluminum alloys *(5, 8)*, Monel *(1)*, and nickel-clad steel *(2, 3)*.

Another solution to the problem encountered in the stowage of fish against wood wings may be the use of screens. Preliminary work has shown that wire screens of 1½ inch mesh, held off the side walls at a distance of about 1 inch, permit the ice to fill the intervening space and hold the fish away from the walls *(6)*. This device was effective in eliminating the occurrence of bilgy fish.

SUMMARY

Of the materials and surfaces studied, rough, unpainted wood boards were shown to be a very serious source of contamination of fish at all levels in the pen. These surfaces could not be effectively washed.

Painted and varnished wood surfaces were impermeable to bacteria in most cases. However, when used commercially, many of these surfaces ultimately become broken and eroded.

Aluminum, or probably any other corrosion-resistant, non-toxic metal, gives a satisfactory surface. Such surfaces provide a reasonable guarantee against bilgy and sour odours, provided the catch is well iced.

If the fish are not protected by the use of all-metal pens, they should be kept away from slime-bearing pen surfaces with ice. Screens along the pen sides are useful aids.

The vertical walls and boards of the pen are the most difficult to ice properly. If only part of the pen can be of metal, the walls should be given priority.

LITERATURE CITED

1. Anon. Capt. Lindquist now lands No. 1's. *Inco* (The International Nickel Co., Inc.) **11** (3), (1932).
2. Anon. January fish in July. *Ibid.*, **14** (3), 1936).
3. Anon. New type holds for trawlers. *Ibid.*, **17** (2), (1942).
4. Castell, C. H. Characteristics of "bilgy" fish. Fisheries Research Board of Canada, *Prog. Rept. Atl. Sta. No. 58* (1954).
5. Goldsworthy, E. C. New materials in fishing vessel construction and operation. *Mimeographed Paper No. 42*, International Fishing Boat Congress, Paris, France, sponsored by the Food and Agriculture Organization of the United Nations, Oct. 12-16, 1953. (To appear in *Fishing Boats of the World* to be published in 1955 by Arthur J. Heighway Publications Ltd., London).
6. MacCallum, W. A. Screens as a protection against contaminated pen walls. Fisheries Research Board of Canada, *Prog. Rept. Atl. Sta. No. 59* (1954).
7. MacCallum, W. A. The construction and use of jacketed, completely refrigerated fresh fish holds. *Engineering J.*, **36**, 707 (1953).
8. MacCallum, W. A. Installation of a unit fish pen. Fisheries Research Board of Canada, *Prog. Rept. Atl. Sta. No. 60* (1954).
9. Shewan, J. M. Some bacteriological aspects of handling, processing and distribution of fish. *J. Roy. San. Inst.*, **69**, 394 (1949).
10. Shewan, J. M., MacIntosh, Ruth G., Tucker, C. G., and Ehrenberg, A. S. C. The development of a numerical scoring system for the sensory assessment of the spoilage of wet white fish stored in ice. *J. Sci. Food Agric.*, **4**, 283 (1953).

A Comparison of Through-Air-Flow and Cross-Air-Flow Methods for the Initial Dehydration of Sweet Corn[a,b]

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A factorial, single-replicated experiment covering five dehydration conditions and two storage variables was used to compare through-air-flow and cross-air-flow methods for the initial dehydration of sweet corn. Differences between replications and other processing treatment variables were either eliminated or largely reduced when the results were corrected for maturity differences. No product quality or stability advantage was apparent for either method of initial dehydration for sweet corn. High-temperature through-air-flow dehydration schedule required an average drying time of about one-fourth that found in cross-air-flow dehydration.

The Armed Forces have shown considerable interest in dehydrated sweet corn as a possible component of field rations. Previous studies have shown definite possibilities for producing an acceptable product *(2, 3, 5)*. Work performed in this laboratory *(3)*, however, indicated a need for further investigation of initial through-air-flow dehydration of sweet corn. Although the through-air-flow system of dehydration had proved desirable for many products, no detailed study of sweet corn had been made.

Objective of the research described here was to investigate the various operating factors affecting through- and cross-air-flow methods for the initial dehydration of sweet corn.

EXPERIMENTAL PROCEDURE

The Golden Cross hybrid variety of sweet corn was selected for this experiment. The sweet corn for each dehydration run was harvested just prior to preparation and processing. Commercial husking and cutting equipment was used in preparing the corn.

Moisture content has been shown, by many workers, to be a good index of sweet corn maturity *(1)*. Three Steinlite moisture determinations were made on each sample as described and suggested by these authors, and the average was taken as the moisture content.

To determine moisture content of dehydrated sweet corn, the sample was ground in a Wiley mill, using a 20-mesh screen. Duplicate 10-gram samples were dried at 70° F. for 16 hours in the vacuum oven as described by Nelson, Kempe, Norton and Howard *(3)*.

Preparation conditions or treatments were mainly selected on the basis of results of studies previously published by our laboratories *(3)*. A flotation-type washer and then a rod-reel washer, with $^{3}/_{32}$ inch spacing between rods, were employed for cleaning all the lots of cut corn just prior to blanching. A 2-minute steam blanch at atmospheric pressure was applied to all samples. Air cooling was used immediately after blanching on all runs. A one percent sulfite solution treatment that had previously *(3)* proved satisfactory from the standpoint of flavor and antibrowning protection was used. The Potter and Hendel *(4)* modification of the sulfite determination by Prater *et al.* was employed in these studies *(3)*.

Through-air-flow dehydration runs were carried out in a drier especially constructed for these studies. A single rectangular tray with an aluminum wire screen bottom held the product during dehydration. A finned coil unit heater was located immediately upstream from the fans. A twelve-point recording potentiometer was used to obtain a continuous record of dry-bulb and wet-bulb temperatures at strategically located positions in the drier. Exit, inlet, and recirculation slide dampers, for air circulation, employed in conjunction with control of the steam pressure in the heating coils, allowed flexibility in control of air temperature, humidity and velocity. The drier rested on two ball-pointed legs at the rear, and a knife-type edge at the front rested on the center of the platform of a 1000-pound scale.

Cross-air-flow dehydration runs were carried out in a cross-tray drier in which air passed across the product and trays. This dehydrator is described in previous studies *(3)*.

The first cross-air-flow drying condition was designed to simulate a center exhaust drier in which air passes across the product and tray. The dehydration run was performed in 4 steps as follows:

Step	T value range[1]	Dry bulb	Wet bulb
		° F.	° F.
1	T_o to 1.5	220	120
2	1.5 to 1.2	190	100
3	1.2 to 0.9	150	100
4	0.9 to 0.5	160	100

[1] T = pounds moisture per pound of bone dry sweet corn solids.

The second cross-air-flow drying condition was designed to simulate a parallel-type drier in which air passes across the product and tray. The dehydration run was carried out in three steps as follows:

Step	T value range	Dry bulb	Wet bulb
		° F.	° F.
1	T_o to 1.5	190	100
2	1.5 to 1.0	175	100
3	1.0 to 0.5	160	100

Air-flow velocity across trays included 2 runs at 400 lineal feet per minute and 2 runs at 900 lineal feet. Tray load was established at 2 pounds per square foot for all simulated, parallel-type and center-exhaust-type cross-air-flow runs.

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[a] This paper reports research undertaken in cooperation with the Quartermaster Food and Container Institute for the Armed Forces, and has been assigned number 501 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsement of the Department of Defense.

[b] Presented at the Fourteenth Annual Meeting of the IFT, Los Angeles, California, June 29, 1954.

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In the selection of dehydration conditions for through flow drying, the choice of dry- and wet-bulb temperatures to be used during the initial dehydration was considered to be of prime importance. In order to have a sound basis for selection of these temperature schedules, a preliminary experiment was carried out.

The most important finding of the preliminary experiment on through-air-flow drying was that sweet corn dehydrated to a moisture content of T = 0.5 at a dry-bulb temperature of 225° F. showed marked heat damage. Drying to this same moisture content at a temperature of 200° F. yielded a product rated as barely acceptable. In those samples taken at the higher moisture level of T = 1.5, the highest temperature applied, 225° F., caused only a slight lowering in acceptability. Air humidity was less critical than temperature. However, use of the higher humidity at 225° F. dry bulb resulted in a relatively lower organoleptic rating.

On the basis of these findings, the decision was made to employ three different temperature schedules of increasing severity. In each schedule, temperature was decreased in 3 steps as drying progressed. The highest temperature schedule was designed to utilize the most severe conditions of temperature that appeared to produce an acceptable product. Conditions selected for through-air-flow drying were:

1) High-temperature dehydration schedule:

Step	T value range	Dry bulb	Wet bulb
		° F.	° F.
1	T_o to 1.5	225	135
2	1.5 to 1.0	200	120
3	1.0 to 0.5	175	110

2) Medium-temperature dehydration schedule:

Step	T value range	Dry bulb	Wet bulb
		° F.	° F.
1	T_o to 1.5	200	120
2	1.5 to 1.0	175	110
3	1.0 to 0.5	150	105

3) Low-temperature dehydration schedule:

Step	T value range	Dry bulb	Wet bulb
		° F.	° F.
1	T_o to 1.5	175	110
2	1.5 to 1.0	150	105
3	1.0 to 0.5	140	100

The two air-flow rates used in the through-flow dehydration study were 150 and 300 lineal feet per minute. The 2 tray loads for the through-flow dehydration were arbitrarily selected as 3 and 6 pounds per square foot.

Finish-drying conditions were similar for both through-flow and cross-flow samples. All products were immediately bin dried from a T value of 0.5 to about a T equal to 0.08. The dry-bulb temperature of the incoming air was 130° F.; wet-bulb temperature was generally about 85° F. The product remained in the bin drier for about 8 hours.

All bin-dried samples were dried in a vacuum tray drier operated at a tray temperature of 100° F. and a pressure below 1 mm. of mercury. After vacuum drying, the moisture content of each packaged sample was adjusted to 5.7% by adding precalculated amounts of distilled water to the individual cans of corn just before the containers were vacuum sealed.

The dehydrated sweet corn was packaged in 211 x 400 plain tin sanitary cans under 26 inches of vacuum and stored at 70° F. and 100° F. Initial, 1½-, 3-, 6-, and 12-month evaluations were carried out.

The procedure to determine the extent of rehydration of final product was similar to that previously followed in this laboratory *(3)*.

Organoleptic testing included the evaluation of 4 factors: (a) flavor, (b) off-flavor, (c) color and appearance, and (d) texture. These factors were scored on the basis of 1 to 10, 5 being considered *acceptable*, 1 *very poor*, and 10 *excellent*. Flavor concerns the presence or absence of normal sweet corn taste and aroma, while off-flavor concerns the presence of sulfite, stale, scorched, or other off-flavors or odors. The factors were averaged and then weighed as follows:

Flavor } (averaged together)	x .5
Off-flavor }	
Color and appearance	x .3
Texture	x .2

A final score of 5 indicated that the product was acceptable. Four to 6 testers were available for each organoleptic examination. The panel was composed of graduate students and staff members.

EXPERIMENTAL DESIGN

Five dehydration conditions and 2 storage variables were included in the experimental design. The experiment was carried out in random order, replicated once. The general plan of the experiment and the preparation, dehydration, packing and storing conditions are presented in Table 1. Included in the

TABLE 1

Dehydration of sweet corn

Through-air-flow versus cross-air-flow dehydration

Preparative Conditions

Variety—Golden Cross, Crookham's Strain
Cut corn
Cleaning—Flotation washer and rod reel
Blanch—Cut corn, 2-minute steam
Cooling—Air
Sulfite—1%, 1 minute dip

Dehydration conditions																
Through air flow T_o to T = 0.5													Cross air flow T_o to T = 0.5			
Low temperature				Medium temperature				High temperature				Parallel air flow		Center exhaust		
Low air flow		High air flow		Low air flow		High air flow		Low air flow		High air flow		Low air flow	High air flow	Low air flow	High air flow	
Lo=X	Lo=2X	Lo=X	Lo=2X	Lo=X	Lo=2X	Lo=X	Lo=2X	Lo=X	Lo=2X	Lo=X	Lo=2X	Lo=3	Lo=3	Lo=3	Lo=3	
Run No. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	

A. Bin Dry T = 0.5 to T = 0.08; Vacuum Dry T = 0.08 to T = 0.05; Package — (Vacuum) Storage Temperature 70° 100° F.

Lo = X = Tray load of 3 lb. per sq. ft.
Lo = 2X = Tray load of 6 lb. per sq. ft.
Lo = 3 = Tray load of 2 lb. per sq. ft.
Block 1 refers to first randomized replicate
Block 2 refers to second randomized replicate

Storage Times
0 -months
1½-months
3 -months
6 -months
12 -months

factorial design were 32 dehydration runs and 320 individual storage conditions.

Maturity of the sweet corn presented a variable that could not be regulated. Analysis of covariance was used to eliminate the effects of maturity differences (as represented by Steinlite moisture of the raw product) on other variables and evaluations. Total water of hydration of the sweet corn after cooking, weighted organoleptic, flavor, color, texture, and off-flavor scores, and sulfite content were used in the statistical analysis to determine the existence of single effects and two-factor interactions. The statistical procedure used to evaluate the effects of dehydration method and technique, storage temperature, and storage time was analysis of variance. Table 2 presents the resulting analysis, with the exception that mean squares for nonsignificant main effects and 2-factor interactions are not presented individually.

RESULTS AND DISCUSSION

Analysis of covariance showed that the moisture content of the raw product was significantly related (1% level) to color of the prepared product and to total water of hydration after cooking. Initial moisture was related to the weighted organoleptic scores at the 5% significance level. Factors of texture, flavor, off-flavor, and sulfite did not show any significant relationship when considered individually with initial moisture.

Color differences in blocks and treatments were largely due to differences in the moisture content of the raw product (Tables 3 and 4). When color values were adjusted for differences in initial raw moisture, most of the differences between blocks and other experimental treatments were eliminated. It was found that 0.21 unit of color resulted from a 1% difference in moisture content. When the moisture content of the raw material was high, color values were invariably low.

The relationship between initial moisture and weighted organoleptic scores followed a pattern which paralleled that found between moisture and color. This relationship was significant at the 5% level, apparently reflecting the effect of color, which is 30% of the weighted organoleptic score.

Initial moisture content was even more important to the values for total hydration after cooking. The relationship between moisture and total hydration was significant at the 1% level. When values for total hydration after cooking were adjusted for moisture, the difference between mean values was in many cases largely eliminated or drastically reduced. It was found that 3.1 g. of total hydration water resulted from a 1% change in initial moisture content. When the moisture content of the raw product was high, total hydration after cooking was also generally high. Experimental factors or treatments apparently did not affect the values for total hydration after cooking.

It will be noted that block variations resulted in some significant differences between replicates 1 and 2 (Table 2). Some variation was expected between blocks, because raw product differences and reproducibility of experimental techniques presented continual problems. Examination of Table 2 shows that the block mean square was small compared with similar values for stored versus unstored, storage temperature, and storage time. This indicates that the variation between blocks was small compared with the variation introduced by single experimental variables, but that the Error I mean square was greatly reduced by eliminating block differences. Evaluations of block variability for flavor, texture, total hydration, and Steinlite moisture did not show any significant difference. Average values representing the relationship between blocks and the interaction between blocks and each of several important single variables are shown in Table 3.

TABLE 2

Effects of seven variables on the preparation and storage of dehydrated sweet corn

Source of Variation	d.f.	Weighted Org.		Flavor		Color		Texture		Off-flavor		Total hydra.		SO_2		Steinlite moisture	
		MS	P	MS	P	MS	P	MS	P	MS	P	MS	P	MS	P	MS	P
Block (B)	1	10.548	.01—	2.295	....	72.104	.01—	.377	....	6.105	.05	63.9	....	1253	.05	268.1	....
Cross or Thru Air Flow (F)	1	.224	....	.277	....	.218	....	.619	....	.155	....	213.7	....	77	....	7.1	....
Cross Air Flow Parallel Or Center Exhaust (E)	1	7.750	....	.760	....	54.780	.01	.338	....	2.628	....	2453.1	....	1519	....	318.4	....
Thru Air Flow																	
Dehyd. Temp. (T)	2	5.383	....	6.213	....	12.852	....	2.144	....	6.364	....	663.9	....	24	....	61.9	....
Cross Air Flow (R)	1	.190	....	0	....	1.351	....	.128	....	.001	....	56.1	....	616	....	1.3	....
Rate of Thru Air Flow (H)	1	4.482	....	3.197	....	5.430	....	1.633	....	4.732	....	10.4	....	427	....	84.8	....
Load (L)	1	.088	....	.630	....	1.785	....	.450	....	2.035	....	60.0	....	1387	....	10.0	....
2 Factor Misc.	6	.719	....	1.879	....	4.182	....	.770	....	.722	....	557.2	....	1198	.01	49.3	....
Bx other Factors	7	2.117	....	1.405	....	10.750	.05	1.394	....	1.893	....	1034.2	....	796	.05	103.3	....
LHT	2	.025	....	.288	....	2.338	....	.771	....	.148	....	54.1	....	438	....	47.8	....
Error 1	8	.854	....	.961		2.884		1.724		.556		850.9		143		63.0	....
Dummy Comparisons	32	.176	....	.330	....	.357	....	.155	....	.330	....	45.8	....	0	....	0	....
Storage Time (V)	3	36.099	.01—	44.706	.01—	46.751	.01—	23.776	.01	34.488	.01—	1331.2	.01—	4304	.01		
VE	3	2.083	.01—	2.428	.01	1.145	.01—	1.607	.05	5.286	.01—	19.1	....	184	.05		
2 Factor	18	.305	....	.724	....	.584	.01	.432	....	.656	....	28.5	....	56	....		
Error II	72	.391		.598		.259		.522		.721		45.4		59			
Storage Temp. (U) x V	3	10.217	.01—	.845	....	18.258	.01—	4.261	.01	.998	....	428.5	.01—	2117	.01		
Error III	93	.267		.606		.313		.393		.579		54.0		59			
U	1	179.895	....	160.180	....	310.421	....	83.722	....	152.832	....	520.4	....	25188	....		
UE	1	7.223	.01—	7.562	.01	11.475	.01	3.377	.05	7.224	.05	606.4	.01	1203	.01		
BU	1	10.726	.01—	11.860	.01	13.643	.01	6.313	.01	10.159	.01—	2.5	....	1743	.01—		
2 Factor	6	.578	....	.280	....	.974	....	.867	....	.667	....	54.4	....	97	....		
Error IV	23	.622		.964		.718		.463		1.140		30.0		122			
Stored or Unstored (S)	1	123.876	....	110.156	....	157.569	....	122.635	....	108.344	....	1893.8	....	13898			
SE	1	2.984	.01	4.233	.01	2.399	.01	2.869	.01	2.720	....	4.3	....	341	.01		
SH	1	1.954	.05	1.989	....	.853	....	1.692	.05	3.232	.05	260.5	.05	33	....		
BS	1	2.777	.01	2.287	.05	5.242	.01	3.004	.01	1.597	....	6.0	....	168	....		
2 Factor	5	.152	....	.230	....	.215	....	.311	....	.388	....	24.3	....	22	....		
Error V	23	.343		.498		.276		.280		.718		39.8		41			

TABLE 3

Effect of the combinations of block and parallel or center-exhaust cross air flow on the weighted organoleptic, sulfite and hydration values

Combination of conditions		Total number samples	Moisture raw product	Total hydration after cook	Organoleptic values					SO_2 p.p.m.
Block	Cross air flow parallel or center exhaust				Weighted organoleptic	Flavor	Color	Texture	Off-flavor	
			percent	*grams*						
1	Parallel	20	70.6	119	6.7	6.7	6.7	6.8	6.6	1139
2	Parallel	20	77.3	130	5.9	6.0	5.4	6.7	5.7	2065
1	Center exhaust	20	69.3	112	6.9	6.4	8.0	6.4	6.3	1732
2	Center exhaust	20	70.6	115	6.9	6.7	7.3	6.9	6.7	1557
Av.	Parallel	40	74.0	124	6.3	6.4	6.0	6.7	6.1	1535
Av.	Center exhaust	40	70.0	113	6.9	6.6	7.7	6.6	6.5	1811
1	Av.	160	70.8	120	6.8	6.6	7.3	6.7	6.5	1709
2	Av.	160	72.6	121	6.4	6.4	6.3	6.8	6.2	1584

Color, weighted organoleptic, and sulfite level values representing parallel and center-exhaust types of dehydration proved to be significantly different (Table 2). Table 3 portrays the average organoleptic, sulfite, and hydration values for simulated parallel and center exhaust types of cross-air-flow dehydration. Little importance can be attached to the significance found in the sulfite values. Weighted organoleptic scores were barely significant. This finding of significance apparently reflected the strong effect of color. The evaluation of color produced a highly significant effect which cannot be readily explained by the principles of cross-air-flow dehydration. Samples representing the center exhaust type of dehydration were significantly superior to the products dehydrated under simulated parallel cross-flow dehydration (Table 2).

Interactions of center-exhaust versus parallel cross-air-flow with other single experimental variables showed that most of the organoleptic, total hydration, and sulfite values representing these interactions were highly significant, the advantage being in favor of the products from the center-exhaust type of dehydration. Center-exhaust samples were found to be generally superior when the interacting factors of stored versus unstored, storage temperature, and storage time came into play. It is apparent that samples dried with a simulated center-exhaust method withstood the longer duration and the higher temperature of storage much better than the products dehydrated with the simulated parallel air-flow method.

However, covariance analysis showed that the significance attributed to color was mainly produced by moisture differences in the raw product. The method of cross-flow dehydration had a lesser effect on the color values. The relationship between moisture and weighted organoleptic scores was significant at the 5% level of confidence. However, it should be remembered that the weighted organoleptic score was influenced to the extent of 30% by color.

When color values were adjusted for initial raw moisture, the difference between the mean values for parallel and center-exhaust treatments was reduced by about one half. Adjusting the total water of hydration mean values for initial raw-moisture levels practically eliminated all differences between the samples representing the two simulated methods of cross-air-flow dehydration. It was quite apparent that the initial moisture content of the raw product produced a more profound effect on the evaluated samples than did the method of cross-air-flow dehydration.

Factors of dehydration temperature, rate of air flow, and tray load were included in the experimental variables covered in through-air-flow dehydration. The variable of dehydration temperature proved to be significant, at the 5% level, for the evaluation factors of weighted organoleptic, flavor, color, and off-flavor (Table 2). Examination of Table 4 shows that the mean values for the low dehydration temperature condition were superior, and those for high and medium temperature followed in order. There is no apparent reason for the inferiority of products prepared at the medium temperature. However, organoleptic scores for the low-temperature dehydration were affected by the lower moisture of the raw product (Table 4). Adjusting organoleptic scores for initial moisture materially reduced the differences in results found between dehydration temperatures. From a practical standpoint, no advantage in quality or stability was apparent for any one of the three dehydration temperatures. However, there still remains the possible economic advantage of lower drying times at higher dehydration temperature schedules.

Variations of air flow produced a significant effect, at the 5% level on weighted organoleptic and off-flavor

TABLE 4

Effect of through-air-flow dehydration temperature on the average organoleptic, sulfite and hydration values

Dehydration temperature	Total number samples	Moisture of raw product	Total hydration after cook	Organoleptic values					SO_2 p.p.m.
				Weighted organoleptic	Flavor	Color	Texture	Off-flavor	
		percent	*grams*						
Low	80	70.6	119	6.9	6.8	7.2	6.8	6.6	1649
Medium	80	72.1	120	6.4	6.2	6.4	6.6	6.0	1617
High	80	72.2	124	6.7	6.7	6.6	6.9	6.5	1646

scores. However, with only two of the organoleptic values significant (and at only the 5% level), it does not appear that any substantial advantage can be attributed to either high or low air flow.

Table 5 portrays average values for the samples involving various storage temperatures. The effect of storage temperature was quite evident, with products stored at 100° F. definitely inferior to the samples held at 70° F. Table 5 also shows a strong relationship between storage temperature and time and the average sulfite level. Storage temperature of 70° F. had a relatively small effect on the sulfite content of the product, while the 100° F. storage catalyzed the gradual breakdown of sulfite over the 12-month storage period.

Storage temperature presented a very strong effect which was highly significant as both a single and an interacting factor. These results concerning the effect of temperature parallel the findings of previous work in our laboratory *(3)*.

Analysis of variance showed the factor of storage time to be highly significant when considered alone and also when interacting with other single variables (Table 2). Table 5 shows average values for all samples according to storage period and storage temperature.

The interaction of storage time with storage temperature was statistically highly significant. Storage temperatures of 100° F. caused rather rapid deterioration of the product. Even short periods of storage at 100° F. reduced the acceptability of the dehydrated sweet corn. Storage times of 12 months at 100° F. resulted in completely unacceptable products. On the other hand, products subjected to storage temperatures of 70° F. for 12 months were quite acceptable. It is apparent, from these results as well as from previous work *(2, 3)*, that storage temperatures above 70° F. were not desirable for dehydrated sweet corn and should be avoided whenever possible.

Drying times from T = initial to T = 0.5 for through-air-flow dehydration runs averaged from one-fourth to one-half the time required for cross-air-flow which was about 170 minutes. In the through-air-flow runs, high drying temperature, high air flow and low tray load produced the lowest average drying time which was 37 minutes. Apparently lack of air percolation through the bed of sweet corn in case of the cross air-flow dehydration necessitated the longer drying time.

SUMMARY

A factorial, replicated experiment covering five dehydration conditions and two storage variables was used to compare through-air-flow and cross-air-flow methods for the initial dehydration of sweet corn.

Analysis of covariance was used to determine the effects of maturity (Steinlite moisture) on other variables and evaluations. Maturity was significantly related at the 1% level to color of prepared product and to total water of hydration after cooking and at the 5% level weighted organoleptic score.

Differences between replications were either eliminated or largely reduced when the results were adjusted for maturity (raw moisture) differences.

Products prepared by through-air-flow and cross-air-flow methods for initial dehydration were not significantly different. Therefore, no product quality or stability advantage was apparent for either method.

Simulated center-exhaust and parallel types of cross-air-flow dehydrated products were found to be significantly different. However, when these treatment values were adjusted for maturity (moisture), practically all difference was eliminated.

Through-air-flow variables of temperature schedule, rate of air flow, and tray load produced several significant single effects and two-factor interactions. Adjustment of the organoleptic scores for maturity materially reduced the differences found among the various through-air-flow variables. From a practical standpoint, no advantage in quality or stability was apparent for any of the through-air-flow dehydration variables.

Storage temperature and storage time exerted very strong effects on product acceptability. Storage at 100° F. for 12 months resulted in completely unacceptable products. However, storage at 70° F. for 12 months yielded acceptable products.

Statistical analysis of sulfite values resulted in a number of significant single effects and interactions. This was especially true when storage conditions and storage interactions were considered.

TABLE 5

Effect of the combinations of storage temperature and storage time on the average organoleptic, sulfite and hydration values

Combination of condition		Total number samples	Moisture raw product	Total hydration after cook	Organoleptic values				SO_2 p.p.m.
Storage temperature	Storage time				Weighted organoleptic	Flavor	Color	Texture	Off-flavor	
			percent	*grams*						
70	0	33	71.7	114	7.9	7.7	8.3	8.0	7.4	2023
100	0	33	71.7	117	7.8	7.7	8.0	8.0	7.6	2063
70	1½	33	71.7	121	7.4	7.5	7.7	7.2	7.1	1917
100	1½	33	71.7	116	6.6	6.7	6.7	6.7	6.4	1815
70	3	32	71.7	117	7.0	7.0	7.4	6.9	6.7	1965
100	3	32	71.7	116	5.5	5.4	5.6	5.7	5.2	1252
70	6	32	71.7	130	7.5	7.3	8.0	7.5	7.1	1814
100	6	32	71.7	121	5.9	5.9	5.6	6.2	5.8	1060
70	12	32	71.7	125	6.6	6.4	7.0	6.5	6.4	1727
100	12	32	71.7	127	3.9	3.8	3.5	4.8	3.8	787
70	Av.	160	71.7	121	7.3	7.2	7.7	7.2	7.0	1897
100	Av.	160	71.7	119	6.0	5.9	5.9	6.3	5.8	1395

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LITERATURE CITED

1. Geise, C. E., Homeyer, P. G., and Tischer, R. G. A comparison of three methods for determination of moisture in sweet corn. *Food Technol.*, **5**, 250-253 (1951).
2. Jerger, E. W., Zoellner, J. A., and Tischer, R. G. Influence of processing variables on drying rate and quality of dehydrated frozen sweet corn. *Food Technol.*, **7**, 200-202 (1953).
3. Nelson, A. I., Kempe, L. L., Norton, H. W., and Howard, L. B. Studies on the dehydration of sweet corn. *Food Technol.*, **8**, 9-14 (1954).
4. Potter, E. F., and Hendel, C. E. Determination of sulfite in dehydrated white potatoes by direct titration. *Food Technol.*, **5**, 473-475 (1951).
5. Tischer, R. G., Jerger, E. W., Kempthorne, O., Carlin, A. F., and Zoellner, A. J. Influence of variety on the quality of dehydrated sweet corn. *Food Technol.*, **7**, 223-226 (1953).

Improvements Required in the Freezing, Storage and Distribution of Frozen Foods

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Rather than extend justifiable praise for the excellent progress and results achieved in the preservation of foods by freezing during the past twenty years, it seems preferable, more fitting, and helpful, to disclose certain unfavorable and critical factors associated with current methods of handling, packaging, freezing, storing and distributing such foods.

Although there are others of less importance, the frozen food industry is confronted with at least three major factors of concern. Briefly, they are: (a) distorted or damaged containers due to the expansion of foods during the freezing treatment, (b) desiccation of foods due to the lack of appropriate packaging, freezing treatment, storage, handling and transportation, and (c) the accumulation of "free" snow in foods packaged prior to the freezing treatment, and to a lesser degree, in foods packaged after the freezing treatment.

THREE FACTORS OF MAJOR CONCERN

Containers. Since all foods used for freezing purposes contain a large amount of water, a considerable amount of expansion occurs in freezing; this often fractures or distorts the containers. This pressure is also very conducive to the breaking-down and otherwise rupturing of the cellular structures of most foods *(2)*. More research is required in this connection, preferably of the kind now being conducted by Dr. Carl Cook of the National Research Council, Canada *(1, 6)*.

Desiccation. Most foods are subjected to air used as a secondary heat transferring vehicle during the freezing treatment. With this in mind, it is understandable that foods at 70° F. would present a vapor pressure at saturation of 52.3 lbs./sq. ft. while the air used for freezing at 0° F. would present only 2.67 lbs./sq. ft. representing approximately 50 lbs./sq. ft./ vapor pressure differential. This in turn will cause a diffusion of moisture from the foods being treated to the adjacent recirculated air used for freezing. There are five other principal factors contributing to this siccative action in foods during their freezing treatment: (a) *The relative humidity of the air to which foods are subjected during the freezing treatment.* The lower the relative humidity, the greater the amount of desiccation. (b) *The air temperature rise during its passage over the foods being treated.* The greater the temperature rise the drier the air becomes, and a corresponding larger amount of desiccation occurs. (c) *The ratio of food surface to volume or mass.* The greater the foods' heat transferring surface with relation to its volume or mass, the correspondingly greater the amount of desiccation. (d) *Unsuitable packaging.* This is one of the principal contributory causes for the lack of water-vapor retention within the frozen food package or container. Lack of water-vapor retention accelerates siccative action, causing a substantial loss in quality, weight and vitamins. It furthers enzymatic action, oxidation, rancidity, and loss of color and flavor *(4)*. It is quite obvious that more care and further research is required if we propose to eliminate or substantially minimize these unfavorable conditions. (e) *The length of time that the foods are exposed to the conditions cited under* (a), (b), (c), and (d). The longer the time, the greater the amount of food desiccation.

Other prevalent conditions cause desiccation of frozen foods in storage, during handling and transportation to the retail market. Included are the relative humidity of the air in the storage room and its corresponding water vapor pressure relative to the vapor pressure presented by the foods. This applies during transportation, handling, and distribution to the retail merchants. Also of significance are the fluctuating temperatures that frozen foods encounter in storage, during transportation, and the necessary handling during their distribution to the retail merchant. All of these critical factors contribute to the very undesirable siccative action which is still occurring in frozen foods before they reach the consumer. Again, it is obvious that more care and further research is very desirable *(3, 5, 7)*.

Free snow. The 'free' snow found in packaged and loosely wrapped frozen foods by the consumer is caused by the existing water vapor pressure differential previously described, together with the numerous fluctuating temperatures to which the frozen food is subjected prior to the consumer's purchase, as previously outlined. It is quite apparent that more research is necessary in this connection.

It is well known that producers of frozen foods not only absorb a substantial loss in saleable food weight due to desiccation, but both the quality and appearance of desiccated foods received by the consumer are considerably impaired. For instance, based on loose and individually frozen peas, lima beans, berries, diced

carrots and the like, and a freezer capacity of 5 tons of frozen foods per hour and a 10% loss in the food weight due to desiccation during the freezing treatment,[a] it is clear that the producer is taking an avoidable loss of approximately 8%. If we consider only 50% of this avoidable loss in weight, in conjunction with a 14c/lb. wholesale selling price, 20 hours per day and 20 days per month food freezing operations at full capacity, the frozen food producer would have to absorb a $28,000.00 loss per month. This loss can be ascribed entirely to the excessive desiccation of the foods during their freezing treatment. Since a properly designed freezer providing suitable means for reducing this loss to less than 2% would only cost $42,000.00, it is quite evident that the producer could well afford to install a new freezer every 2 months and still show a $14,000.00 saving in connection with the costs involved in his freezing operations. This, of course, would be totally unnecessary. An adequately designed, tested, and properly installed freezer of this capacity should be in excellent operating condition and producing its initial capacity of frozen foods after 20 years of continuous service.

FURTHER CONSIDERATIONS

The importance of effective distribution of the secondary heat transferring vehicle over both the primary refrigerant's heat exchange surface and the surface of the foods being treated is frequently overlooked. For instance, in the freezing treatment of hams, roasts of meat, round fish, poultry and the like if the secondary refrigerant is continuously circulated over such foods in one direction, the point of final solidification will be far off the center of such foods. Hence, the freezing time is often increased well over 50%, and the food freezing capacity is reduced a corresponding amount. It is impractical, of course, and otherwise very undesirable, to direct the air over the foods from both sides at the same time, since the static pressure on both fans would be greatly increased, and the velocity head on each fan would be lost so far as useful work in heat transfer is concerned. However, this phase can be easily and economically accomplished by reversing the directional flow of air over the foods several times as the freezing action progresses, thereby increasing the rate of heat transfer, food freezing capacity, and substantially reducing as well the freezing time.

The further necessity and importance of effective distribution of a secondary heat transferring vehicle over the heat exchange surfaces of the primary refrigerant, and over the surfaces of the foods being treated, at an appropriate velocity, cannot be overemphasized. Air and all other fluid heat vehicles form an almost stagnant film on the heat transferring surfaces; this in turn greatly retards heat transfer. Effective distribution together with suitable velocity of the heat vehicle over the foods and the primary heat exchange surfaces tends to break down the thickness of the film and expedites heat transfer of both food and refrigerant heat transferring surfaces. A like condition always exists on the internal tube or pipe surfaces of the refrigerant evaporator being used for cooling the secondary refrigerant.

In brief, short-circuiting or by-passing the secondary heat transferring vehicle should be carefully avoided and the larger amount of the frictional resistance offered to flow of the fluid heat vehicle should be motivated by the heat transfer surfaces of the primary refrigerant and foods being treated. It is now well known that, in this instance, heat transfer will vary as a function of friction. Hence, it behooves us to utilize as much of this frictional resistance on the heat transferring surfaces as possible in the production of useful work, coinciding with the economical point of power input.

[a] This loss (10%) is not unusual; the maximum loss during freezing treatment should not, it has been shown, exceed 2%.

LITERATURE CITED

1. Bush, V. *Annual Report of the Carnegie Institute* (1953).
2. Finnegan, W. J. The Effect of Expansion on Foods and Containers Due to Freezing Action. Report to The Refrigeration Research Foundation (February, 1949).
3. Finnegan, W. J. Drying of foods by freezing. *Ice and Refrigeration*, January, 1944.
4. Finnegan, W. J. Methods of Improving Food Freezing Operations. Presented at the 27th Annual Convention of the National Association of Practical Refrigerating Engineers, Saint Louis, November 27, 1946.
5. Finnegan, W. J. The quick freezing and storage of poultry. *Ice and Refrigeration*, January, 1941.
6. Lusena, C. V., and Cook, W. H. Ice propagation in systems of biological interest. I and II. *Arch. Biochem. Biophys.*, **46**, (1) (1953).
7. Woodroof, J. G., and Rabak, W. Protective packaging of frozen foods. *Refrig. Eng.*, **62**, (2) (1954).

Microscopic Structure of Frozen Cake Batters[a]

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(Manuscript received December 6, 1954)

The microscopic structure of cake batters as affected by frozen storage was studied. Volume and texture changes in cakes baked from frozen batters were also investigated. Changes in batter structure during frozen storage result in loss of volume and compactness of texture in cakes baked from such batters.

Cake batters have little tolerance to freezing as evidenced by poor cell structure and small volume of cakes baked from frozen batters *(6)*. These tendencies become more pronounced as freezing is prolonged, until after approximately 12 weeks at 0° F. frozen batters may fail to rise when baked, resulting in cake failures. A storage period not to exceed 8 weeks at 0° F. has recently been recommended *(7)*.

A close relationship between batter structure and cake quality has been demonstrated for freshly prepared cakes *(3)*. Fine texture and good volume depend upon the incorporation of air by the fat, and the uniform distribution of aerated fat films throughout the batter. The entrapped air is essential to the development of cake structure. Hood *(5)* demonstrated that when no air was present in the batter, the normal cell structure of the cake did not develop. Indeed, the batters from which the air had been evacuated yielded cake failures much resembling the cakes baked from frozen batters.

Disturbances of the important pattern of fat and air distribution take place during the freezing process and during the ensuing period of frozen storage and thawing. This paper reports a study of the microscopic structure of cake batters as affected by frozen storage and a parallel study of volume and texture changes in cakes baked from frozen batters.

PROCEDURE

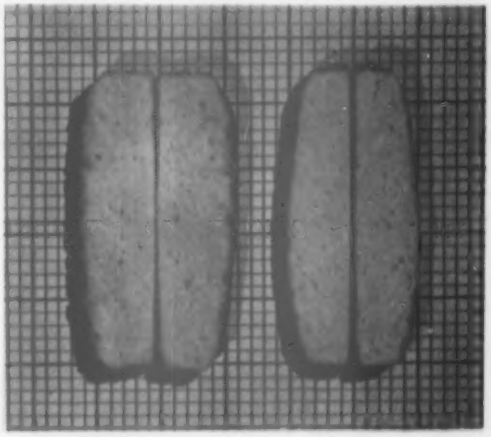
A high-sugar yellow cake formula prepared by a conventional method was used. Two series of batters were prepared, the first to be baked for studies of volume and texture; the second made with red-stained shortening for microscopic studies of batter structure. Part of the red-stained series was also baked as a check on whether changes in cake texture or volume were brought about by use of the dye.

Equal portions of batter were weighed into small round tin pans, and baked immediately or covered and frozen at 0° F. An oven temperature of 190° C. was maintained during the baking period. Preliminary work had demonstrated that better cake volumes resulted when batters were thawed before baking. Frozen batters were removed from the freezer, placed on racks and allowed to stand at room temperature, 25° C., for 3 hours, at which time the interior temperature had reached 25° C.

The tests were carried out when batters were freshly prepared, and after the batters had been stored 4 and 12 weeks at 0° F. One red batter was stored for 12 months. Photomicrographs were made to show the fat and air distribution in the cake batters. Cross section areas of the cakes were measured as an indication of volume, and observations were made on crumb texture.

RESULTS AND DISCUSSION

The cakes baked from frozen batters became smaller as the period of frozen storage advanced. The texture also changed, becoming increasingly compact the longer the batters were stored. The loss in volume and compactness of texture following freezing for 12 weeks are illustrated in Figure 1.



A B

Figure 1. Cakes baked from (a) freshly-prepared batter and (b) batter frozen 12 weeks.

When viewed under the microscope, frozen batters presented a different picture from the freshly prepared. In the freshly prepared batters the fat was dispersed in aerated particles and in thin patches most of which showed filmy edges where in contact with the aqueous phase. Globules of fat appeared only occasionally. The most prominent feature in these batters was the clustering of closely-packed small air bubbles within fat particles. In frozen batters, air bubble clusters were much less numerous. Instead, large isolated bubbles were dominant, as if the clusters had broken or the air bubbles had coalesced, Figure 2. Fewer fat particles occurred as thin, irregularly-shaped films. The fat tended to pull sharply away from the aqueous phase, forming distinct rather than filmy boundaries, Figure 3. These tendencies became more pronounced as the storage period was prolonged. After 12 months at 0° F., nearly all the fat particles were globular in shape and most of the air previously entrapped by the fat was lost.

The failure of frozen cake batters to produce cakes of satisfactory volume and texture appears to be due

[a] Approved for publication as technical paper No. 884 by the Director of the Oregon Agricultural Experiment Station. Contribution of the Department of Home Economics.

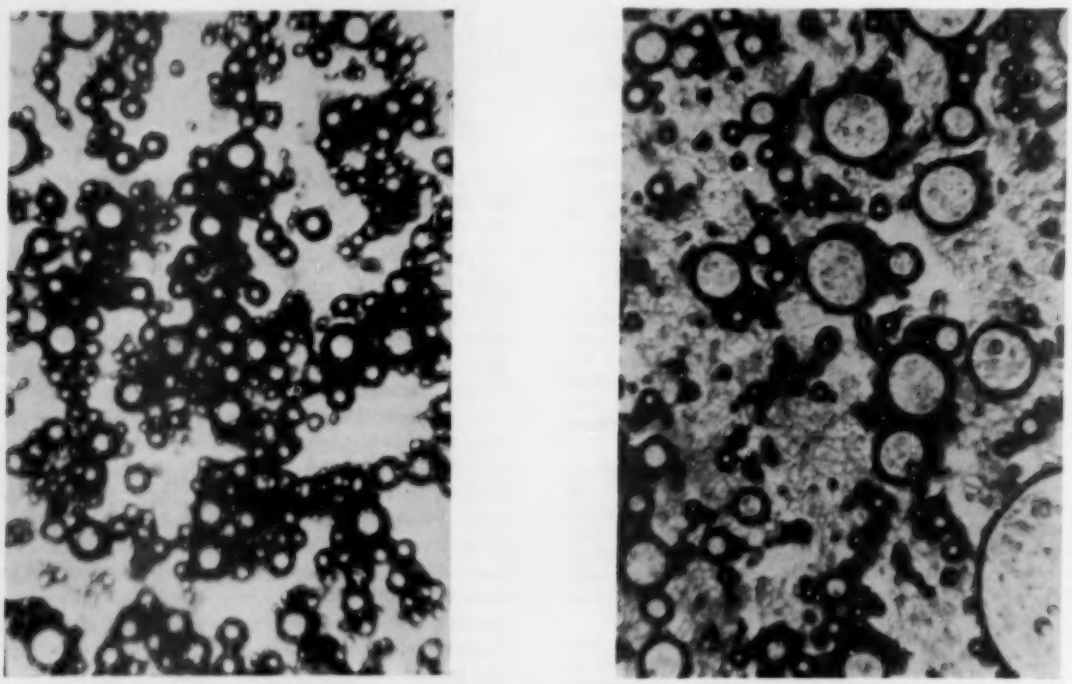
largely to the breaking of interfacial films which normally stabilize the interfaces fat/air and fat/water. After the films are weakened or broken the fat tends to form globules and entrapped air is released from the fat particles. Some coalescence of air bubbles undoubtedly takes place as the batter thaws. During baking such large air bubbles easily escape from the warm batter. Once the emulsion and foam are broken through loss of the stabilizing action of interfacial films, the air distribution necessary for normal cake texture and volume is lost.

During freezing of a cake batter the following changes probably take place: association of water molecules or formation of ice crystals; dehydration of phospholipid-protein complex; slower diffusion of molecules to surfaces; increased concentration of water-dissolved substances resulting in increased density of aqueous phase; weakening of gluten proteins.

Adam *(1)* states that the effectiveness of certain surface-active materials in stabilizing foams appears to be due not only to their tendency to concentrate in the interface but to their properties in concentrated surface films. A stable film should be able to easily and quickly vary in surface tension, both in order to meet permanent differences of stress in its different parts, and to absorb local mechanical shocks. The speed with which surface-active molecules can diffuse from the surface to the interior, and vice versa, is probably important in determining the stability of the film.

One of the important stabilizers in yellow cake is the lecitho-protein complex of egg yolk. The association of water molecules or formation of ice crystals which takes place in frozen batters is accompanied by dehydration of surface films of phopholipid-protein complex. When dehydrated in the freezing process, this substance loses its hydrophilic properties and associates with the fat phase, thus losing its efficiency as an emulsifier.

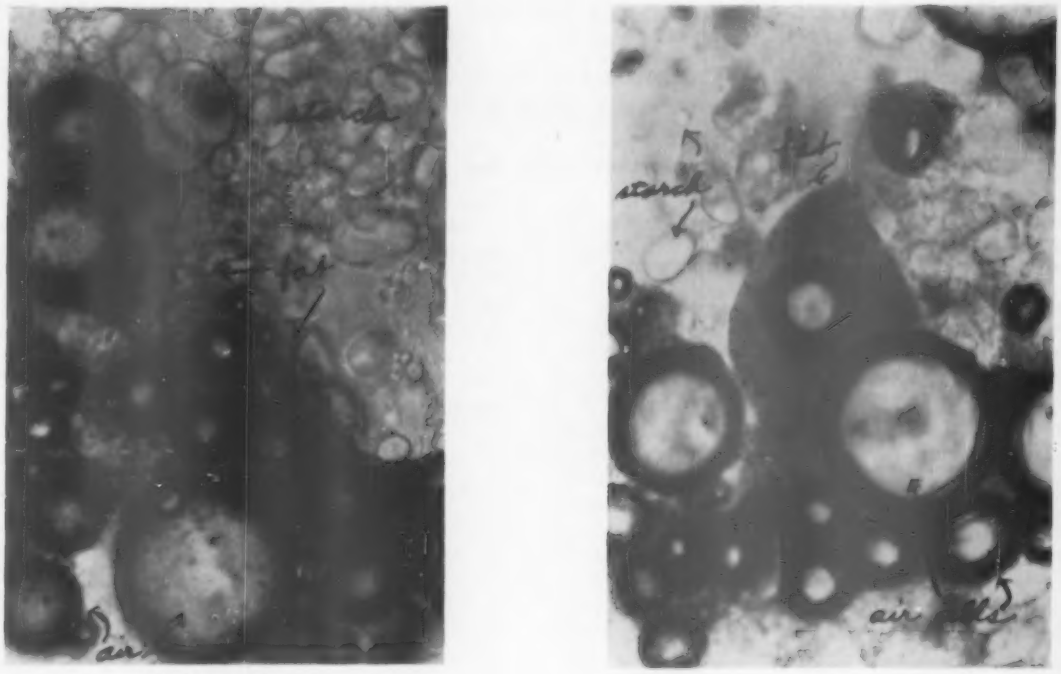
Gluten proteins also undoubtedly collect at bubble surfaces during preparation of a batter, since protein solutions are known to form visible skins spontaneously both at the air/water and the oil/water interface *(2)*. As water is removed from solution by crystallization of ice, the concentration of sugar, salts and other dissolved constituents increases. The increased concentration of these substances may weaken the protein films. Haurowitz *(4)* states that the solubility of proteins is increased by the addition of small amounts of salts, but soluble proteins are precipitated by high concentrations. This is due to a competition between the salt and the proteins for molecules of the solvent. He also points out that the solubility of proteins in general is decreased when the temperature is lowered. The concentration of solutes as well as the low temperature decrease hydration of gluten proteins. Rochow and Mason *(8)* state that dehydration of interfacial films seems to be essential in the breaking of emulsions during freezing. Water is withdrawn from the films by crystallization as ice or by concentration of solutes present. The films may be completely dehydrated or may be penetrated by small ice crystals. In addition to its dehydrating effect, the



FRESHLY PREPARED
Dominant feature, densely clustered air bubbles.

FROZEN
Large air bubbles replace clusters of small bubbles.

Figure 2. Photomicrographs (× 100) of cake batters: Fat appears dark gray; air bubbles, round with black edges; starch granules, gray and white network in background.



FRESHLY PREPARED
Edge of fat film blends with aqueous phase.

FROZEN
Fat separates sharply from aqueous phase.

Figure 3. Photomicrographs (× 450) of cake batters: Fat appears dark gray; air bubbles, round with black edges; starch granules, tiny round and larger ellipsoidal particles in the background.

association of water molecules which takes place at low temperatures impedes the free diffusion necessary for film stability. Increase of interfacial tension takes place as the temperature is lowered. As interfacial tension increases, diffusion of molecules to the surface decreases, resulting in loss of stability of the surface films. The decreased stability of the interfacial films results in coalescence of air bubbles, while the fat particles tend to pull away from the aqueous phase and form discreet particles.

SUMMARY

The microscopic appearance of frozen cake batters differs from the freshly prepared. Air bubbles embedded in fat particles appear to coalesce and the fat tends to pull away from the aqueous phase. Changes in batter structure which take place during frozen storage are reflected in loss of volume and compactness of texture in cakes baked from these batters.

LITERATURE CITED

1. Adam, Neil K. *The Physics and Chemistry of Surfaces.* 3rd ed., 1941, Oxford Univ. Press, London.
2. Alexander, A. R. *Colloid Science, a Symposium.* 1947, Chem. Publ. Co., New York.
3. Carlin, G. T. A microscopic study of the behavior of fats in cake batters. *Cereal Chem.*, 21, 189-199 (1944).
4. Haurowitz, Felix. *Chemistry and Biology of Proteins.* 1950, Academic Press Inc., New York.
5. Hood, Maude Pye, and Lowe, Belle. Air, water vapor, and carbon dioxide as leavening gases in cakes made with different types of fats. *Cereal Chem.*, 25, 244-254 (1948).
6. Mackey, Andrea Overman, Jones, Patsy, and Dunn, Joyce. The effect of ingredient variations on the quality of white and chocolate cakes baked prior to freezing or baked from frozen batters. *Food Research*, 17, 216-224 (1952).
7. Paul, Pauline, Batcher, Olive M., and Fulde, Lilian. Dry mix and frozen baked products, I. Dry mix and frozen cakes. *J. Home Econ.*, 46, 249-253 (1954).
8. Rochow, T. G., and Mason, C. W. Breaking emulsions by freezing. *Ind. Eng. Chem.*, 28, 1296-1300 (1936).

A Study of Color Change in Stored Apple Juice Concentrates[a]

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(Manuscript received June 18, 1954)

Full-flavor 68°-69° Brix apple juice concentrates were stored at 5°, 25°, and 37.8° C. (41°, 77°, and 100° F.). Measurements of color density were made at frequent intervals for periods up to a year and plotted graphically. The effects of ion-exchange and various other treatments of the juices before concentration upon the rate of darkening of the concentrate were demonstrated.

A problem of some importance in the marketing of fruit juice concentrates for beverage purposes is their lack of color and flavor stability on unrefrigerated storage. Concentrates containing more than 65% total solids are normally stable against fermentation at any temperature; but when stored at elevated temperatures, those of some fruits turn dark and develop off-flavors. If means could be found to reduce these changes, such products could be stored under temperature conditions which are not now satisfactory for products of this type. This would result in considerable saving in warehousing and marketing costs. It would also increase the feasibility of their use in rations for the armed forces, where elevated storage temperatures are often encountered.

Darkening or browning is also a problem in the utilization of fruit concentrates for non-beverage purposes; for example, in the manufacture of candies, confectionery gels (for use with bakery products) and apple-fruit jellies. In the latter case, a dark-colored apple concentrate tends to mask the bright color of the other fruit.

A method for preparing a high density, full-flavor apple juice concentrate has been developed by Eskew, Redfield, and Phillips of the Eastern Utilization Research Branch *(3)*, based on the recovery and concentration of the volatile flavors by Milleville and Eskew *(5)*, these flavors being reincorporated after the remaining juice has been depectinized and concentrated to 71° Brix. The resulting 68.5° Brix concentrate may be reconstituted by the addition of 6 volumes of water, to give a 12.5° Brix full-flavor juice, substantially equal in quality to the fresh juice.

The concentrates described above do not have to be frozen. At 35° F. (1.7° C.) they may be stored for a year or more without serious loss of color or flavor. Recent modifications of the process have made it feasible to store these concentrates at normal room temperature also. However, at the higher temperatures which may sometimes be found in commercial storage, and which often prevail in military storage, serious darkening and deterioration of flavor may take place.

Color changes may be conveniently measured on small samples, but the measurement of flavor changes requires larger quantities of juice, and involves more complicated procedures. Therefore, the present study attempts only to follow changes in color during storage. Since the relations between color changes and flavor changes have not been definitely established, the latter will require a separate study.

EXPERIMENTAL PROCEDURE

The apple juice was prepared from a blend of varieties consisting of two parts of Jonathan and one part each of McIntosh, Northern Spy, and Stayman Winesap. Immediately after pressing, the juice was passed through an essence recovery apparatus *(3)* from which the volatile flavors were recovered in the form of an essence having 1/150 the volume of the original juice, and was simultaneously pasteurized by a 4-second heating at 101° C. (214° F.). The stripped juice was then clarified by adding Pectinol A,[c] allowed to stand overnight at room temperature, filtered, heated to 99° C. (210° F.) in less than 2 seconds to inactivate the enzyme, and cooled instantly by flashing into a vacuum. It was then run into 3-gallon enamel-lined tins and frozen. Cans of frozen juice were withdrawn and thawed when desired for experimental work. The stripped juice had a Brix value of 18.3°. The pH was 3.35, the total titratable acidity 0.705% (calculated as malic acid), and the total nitrogen 6.9 mg. per 100 ml. (determined by micro-Kjeldahl method).

The juice was concentrated in a laboratory vacuum still consisting of a 500-ml. round-bottom flask, a Friedrichs condenser, and an ice-cooled suction-flask receiver connected to an aspirator. The distilling flask was heated gently in a water bath, the temperature of the distilling vapor being kept below 35° C. (95° F.). When the contents of the flask reached 71° Brix or slightly above, the distillation was stopped. The concentrate was mixed with the amount of apple essence that had been recovered from the juice used to make it, and the concentration adjusted to 68.5° Brix + 0.5°. All Brix measurements were made on an Abbé refractometer, using the sugar scale.

Color was evaluated by means of a Klett-Summerson filter photometer, using standardized test tubes. The tubes were filled to the 10-ml. mark and closed with cork stoppers. There was approximately 5 ml. of air space between the surface of the liquid and the cork. The filter used in the photometer was prepared by combining a blue glass with an orange glass. This filter gave a single, rather narrow peak of transmittance in the yellow range with the maximum point at 565 millimicrons. Scale reading, proportional to absorbance, or optical density, was used as an index of color or darkening.

Three storage temperatures were chosen. The first group of samples was stored in a laboratory refrigerator at 5° C. ± 2° (41° F.). The second group was stored in the dark at room temperature at 25° C. ± 5° (77° F.). The third group was stored in an incubator at 37.8° C. ± 0.2° (100° F.). These temperatures were designated as low, medium, and high, respectively. The low and medium temperatures represent the usual conditions for storing fruit juice concentrates in commerce. The high temperature is that commonly used, for example, by the Quartermaster Corps, as an extreme test for storage stability.

[a] Presented at the Fourteenth Annual Meeting of IFT, Los Angeles, California, July 1, 1954.

[b] A laboratory of the Eastern Utilization Research Branch, Agricultural Research Service, U. S. Department of Agriculture.

[c] The mention of commercial products is not to be construed as an endorsement by the U. S. Department of Agriculture over other products not mentioned.

Color measurements were made on each sample at the time of preparation, and at frequent intervals thereafter (usually 5 times each week) for periods up to a maximum of a year. The tubes of the low temperature series were removed from the refrigerator and allowed to warm up to a temperature above the dew point before making the readings. Each tube was carefully dried before placing in the colorimeter. In order to make sure that these short periods of warming up did not materially affect the rate of color change, a few checks were made by removing some tubes for reading only once a week. Readings on these samples did not differ significantly from those made on duplicate samples which were read more frequently.

Readings with the yellow filter were discontinued when the values reached 900 on the colorimeter scale. In some cases, however, further readings were made beyond this point by substituting a standard red filter (No. 66), which gave lower values of absorbance.

RESULTS

Figures 1 and 2 demonstrate the rate of darkening of a typical apple juice concentrate at three temperatures. Figure 1 is a magnified section of Figure 2, covering the first 45 days of storage. The rapid increase at medium and high temperature during the first few days of storage was obtained in every case with concentrates from untreated juice. At 25° C. the color reading rose sharply after 1 or 2 days and reached a peak at 5 to 7 days, then fell slightly and leveled off. At 37.8° C. the rise began immediately, and a peak was reached in 1 or 2 days, followed by a sharp drop. The peak at the high temperature may be lower in magnitude than that at the medium temperature, but sometimes reaches almost the same value. At 5° C. the curve started out level, or with a slight drop.

Visual observation showed no turbidity during the period in which these peaks appeared, and the change in color was easily detectable by the eye. A sample of concentrate from untreated juice, stored at 25° C., which reached a color peak at 7 days' storage, was examined under a light-scattering photometer and showed only a slight increase in light-scattering effect. Filtration through a fine sintered glass filter caused no decrease in color reading. Therefore, it may be assumed that the peaks represent an actual increase in color, rather than an increase in turbidity.

These preliminary peaks might be explained by the existence of a relatively rapid oxidation, independent of the overall browning reaction. With concentrates containing ascorbic acid, they are absent or considerably diminished.

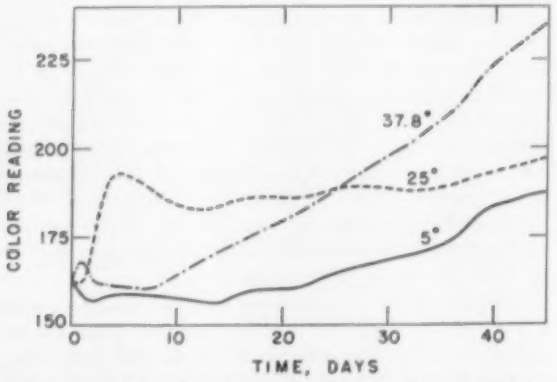

Figure 1. Color change in untreated apple juice concentrate.

Figure 2 shows the curves extended to cover a period of 9 months. The curves for the low and medium temperatures were close together and parallel from 1 to 3 months, after which they began to diverge, the low temperature curve leveling off and remaining practically flat for the rest of the period, while the medium temperature curve continued to rise at a practically constant rate. From 9 to 12 months, although not shown in the figure, both curves continued as approximately straight lines. The high temperature curve rises steadily after the first 10 days, the slope of the curve increasing in steps up to 3½ months. Beyond the latter point, the curve was practically straight. The maximum readable value of 900 was reached in 5½ months.

Effect of presence of essence. Since the reincorporation of volatile flavor concentrate (essence) was an integral part of these experiments, the question arose as to the possible effect of its presence upon the rate of darkening. Therefore, a sample of concentrate was prepared to one portion of which the usual amount of essence was added. The remaining portion was reduced to 68.5° Brix by the addition of water and stored without added essence. The rates of color change were not significantly different.

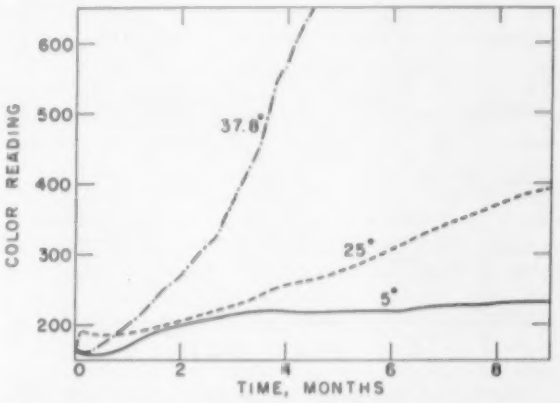

Figure 2. Color change in untreated apple juice concentrate.

Effect of light. A sample of concentrate was exposed to diffused daylight by placing near a north window of the laboratory. The rate of color change did not differ significantly from that of the same concentrate stored in the dark at the same temperature.

Effect of lack of air space. Three tubes were prepared by filling with concentrate to a level one-half inch from the top and filling the tube with melted paraffin wax in order to eliminate the head space. These tubes were stored at all three temperatures and compared with samples of the same concentrate prepared and stored in the usual manner. At low and medium temperatures the curves were identical for the first 5 months, after which they diverged somewhat. At the end of a year, the color reading of the sample in the tube without head space was 40 units lower at the low temperature and 95 units lower at the medium temperature. At the high temperature, the curves began to diverge at 1½ months, and the tube without head space required about 3 weeks longer to reach a reading of 900.

Effect of ascorbic acid. Ascorbic acid was added to a sample of the stripped juice at the rate of 0.5 g. per liter before concentrating. Comparison was made with a control sample prepared at the same time. The starting color for the treated concentrate was 151 as compared to 173 for the control. As noted above, the usual initial peaks were absent. In fact, the medium and high temperature samples showed a drop of 17 to 25 units in the first 2 days. The low temperature curve was almost flat up to 2½ months, after which it rose gradually and approached the curve for the control, merging with the latter at 11 months. The medium temperature curve, after an initial dip and recovery, rose only slightly up to 2 months, then more rapidly, crossing the control curve at 2½ months. At 5 months the curves recrossed, and from then on the ascorbic acid sample was appreciably lighter than the control. At the high temperature, the ascorbic acid sample darkened somewhat more rapidly than the control, perhaps as a result of

the formation of colored products by reaction of the ascorbic acid itself.

Effect of decolorization with carbon. A sample of the stripped juice was stirred with decolorizing carbon (Darco G-60) at 70° C. (158° F.) for 20 minutes, then filtered and concentrated. The color change, shown in Figure 3, may be compared with that

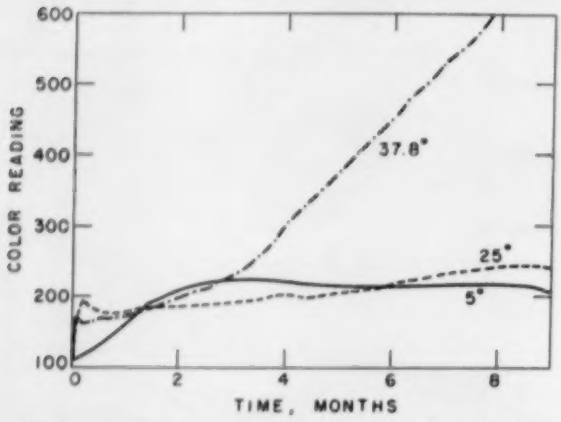

Figure 3. Color change in concentrate from apple juice treated with decolorizing carbon.

of the control, which is shown in Figure 2. The starting color of the treated concentrate was 109 as compared to 163 for the control. The medium and high temperature curves rose rapidly and then leveled off. The low temperature curve rose at a moderate constant rate, intersecting the other two curves at 1⅓ months. It continued to rise up to 3 months and then began a gradual decline. The medium temperature curve rose slowly in a straight line, crossing the low temperature curve at 5⅔ months. The high temperature curve rose more rapidly, but the slope was much less than that of the control.

Effect of bisulfite. A sample of freshly-prepared concentrate was treated with sodium metabisulfite in an amount equivalent to 200 p.p.m. of SO_2. The treated concentrate was stored without air space in test tubes sealed with paraffin. At the low temperature, the color decreased slowly, dropping 20 units in 6 months. At the medium temperature, it dropped 50 units in the first 1½ months and then remained practically constant up to 6 months. At the hgh temperature, it dropped over 50 units in the first 10 days, then began to rise, the slope of the curve increasing gradually. After 5 months the rate of increase was about the same as it would have been in an untreated sample. These data seem to indicate that sulfur dioxide reacts with certain pigments and color producing compounds in the concentrate, and that this reaction takes place more rapidly and reaches completion more quickly at the higher temperatures.

Effect of added amino-acids. The relationship between amino-compounds and browning is well recognized. The reactions between amino-acids and reducing sugars, in which melanoid pigments are produced, have been thoroughly investigated in model systems, and their relations to browning in many natural foods and processed food products have been studied. Apple concentrate contains small amounts of amino-acids, which probably play a part in the color changes noted above. It was therefore decided to test the effect on rate of darkening of adding small quantities of specific amino-compounds to the juice before concentration. Aspartic acid, glutamic acid and glutamine, which were all found to be present in the juice (at a level of about 5 to 15 mg. per liter), were chosen for this test.

Samples of stripped juice were treated by adding aspartic acid, glutamic acid and glutamine, respectively, at the rate of 20 mg. per liter, and were then concentrated in the usual manner. A sample of untreated juice was concentrated at the same time as a control. All samples were stored at the usual temperatures. At the low temperature the color curve for the concentrate containing glutamine was essentially identical with that of the control. Those for aspartic and glutamic acid were slightly higher, the differential at the end of a year being 24 units for the former and 28 for the latter. At the medium temperature all treated samples darkened appreciably faster than the control, especially during the period between 2 and 8 months. Thereafter, the curves were essentially parallel. At the high temperature, the treated samples all darkened more rapidly than the control up to 3 months, and at about the same rate thereafter.

ION-EXCHANGE TREATMENT

Since amino-acids play a part in the darkening of apple concentrate, it should be possible, by reducing the amino-acid content of the juice, to reduce the rate of darkening. Challinor, Kieser and Pollard *(1)*, by means of a three-stage ion-exchange treatment, were able to reduce the nitrogen content of apple juice to the point where it would no longer support fermentation. Marshall and Walkin *(4)* produced a similar result by a single passage through a strongly acidic cation-exchange resin. This type of resin has been shown *(2)* to take up all amino-acids by reaction with the amino-group, whereas anion-exchange resins do not remove the basic amino-acids. Since cationic and anionic constituents were shown to be removed to a greater extent than the total nitrogen *(1)*, the estimation of total nitrogen may be used to indicate the degree of removal of amino-acids.

Marshall and Walkin found that ion-exchange treatment of fresh juice removed a large part of the volatile flavor. This involves no disadvantage when the treatment is applied to stripped juice, as in the present study.

Preliminary experiments were carried out by stirring stripped apple juice with varying amounts of several different cation-exchange resins. As a result of these tests, Zeo-Rex, a strongly acidic sulfonated phenolic resin, was chosen for the succeeding experiments. A 200-ml. bed of resin was prepared in a 1-inch column. Regeneration was carried out with 2% sulfuric acid.

Stripped apple juice was run through the column and the effluent collected in fractions. Each fraction of the first run was tested for pH, Brix, color and total nitrogen. The nitrogen content of the effluent began to increase at the same point at which the pH began to rise; consequently, the pH change was chosen as a guide for subsequent runs. All fractions showing the minimum pH were combined. The volume of this combined effluent varied from 1500 to 1800 ml. per run. The pH varied in different runs between 2.1 and 2.3 and the total nitrogen between 1.0 and 1.7 mg. per 100 ml., as compared to 6.9 for the stripped juice.

Samples of the effluent were restored to the original pH by the addition of NaOH solution, then concentrated, and the concentrate stored in the usual way. Figure 4 shows the rate of darkening for a typical sample. The starting color of the concentrate was 110 as compared to 163 for the control (Figures 1 and 2). At the low temperature the color was constant for 12 days, rose fairly rapidly to 1½ months, then slowly to 6½ months, and then remained nearly constant. From 6 months on the curve was practically identical with that of the control. At the medium temperature, after a rapid

rise, the color was almost constant up to 2½ months and then rose gradually, remaining well below the control. After 11 months it was 80 points lower than the control. At the high temperature there was a rapid rise, a short dip, and a general rise. The rate of darkening was well below that of the control.

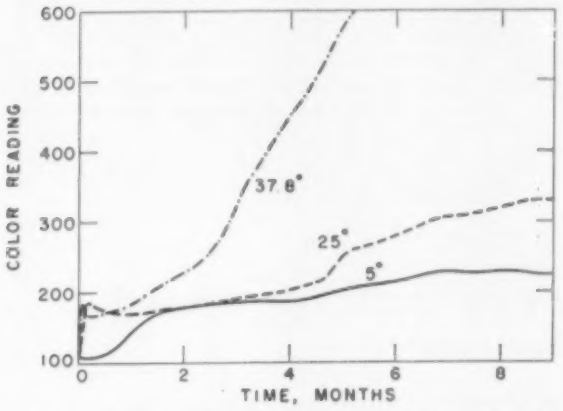

Figure 4. Color change in concentrate from apple juice treated with cation exchange resin.

Ion-exchange may be effectively combined with other treatments. When carbon-decolorized juice was passed through the cation-exchange column, it showed a marked decrease in rate of darkening at medium and high temperatures. An example of what may be accomplished by combined treatments is shown in Figure 5, which gives color curves for a concentrate prepared from stripped juice which had been treated with carbon,

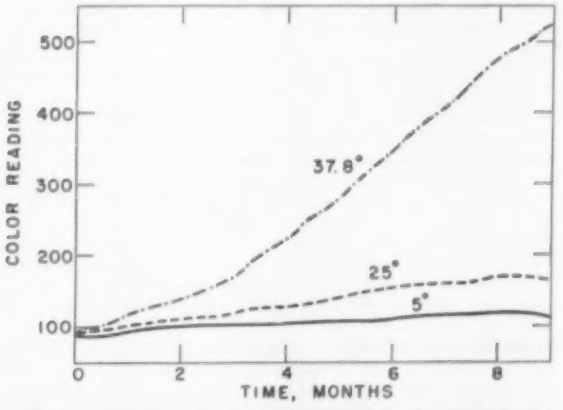

Figure 5. Color change in concentrate from decolorized apple juice treated with cation exchange resin and ascorbic acid.

passed through the cation exchanger, and treated with ascorbic acid. Preliminary peaks are absent. At the low temperature, the curve is almost level for the entire period. At the medium temperature the rate of darkening is quite low. Even at the high temperature, the color reading is only 520 after 9 months' storage, whereas untreated concentrates would have long since passed the maximum readable value.

Two-stage ion-exchange treatment. Samples of stripped juice were passed through the cation-exchange column in the manner described above, and the effluent was passed through a column containing Permutit S-2,[e] a strongly basic anion-exchange resin. The effluent had a nitrogen content of 0.62 mg. per 100 ml. and a titratable acidity of 0.013% as malic acid. The pH was approximately the same as that of the original stripped juice. This juice was of no value as a beverage, on account of its very low acid content. Therefore the acidity was restored by the addition of pure organic acid in an amount equivalent to the original acidity of the juice. The pH was then adjusted with sodium hydroxide, and the juice was concentrated. Three acids—malic, citric, and tartaric—were used for the acidification. At low and medium temperatures, these concentrates showed practically no darkening at all over a period of more than 6 months. At the high temperature the rate was still quite low, varying somewhat with the acid added, with tartaric the highest and citric the lowest. At the low temperature, tartaric acid began to crystallize out after 2 months' storage. It should be noted that citric acid alters the flavor of the juice considerably and tartaric acid to a lesser extent. These flavor changes are not in any sense deleterious. They are, in fact, preferred by some tasters.

Two-stage ion-exchange was the most effective treatment of all those tested in this study at low and medium temperatures. At the high temperature, carbon treatment plus single-stage ion-exchange gave the best results.

SUMMARY AND CONCLUSIONS

The darkening of full-flavor apple juice concentrate was studied at three temperatures, viz., 5°, 25°, and 37.8° C. (41°, 77°, and 100° F.). In general, the rate of darkening is a positive function of the temperature. Untreated concentrates undergo an immediate rapid rise in color at high and medium temperatures, followed by a short drop or a leveling off. The presence of essence does not appreciably affect the rate of darkening. Light does not increase the rate of darkening at room temperature. The elimination of air space results in less darkening from 3 months on at low and medium temperatures, and from 1½ months at high temperature. Ascorbic acid gives lighter concentrates at low temperature up to 11 months and at medium temperature from 5 months on. At the high temperature, ascorbic acid increases the rate of darkening. Concentrates from juices decolorized with carbon darken rapidly at first, but the overall rate is lower than for control samples. Bisulfiite causes a rapid lightening of color at high and medium temperatures, but at the high temperature, the effect is only temporary. The addition of aspartic acid, glutamic acid, or glutamine increases rate of darkening.

A single pass through a Zeo-Rex cation-exchange column reduces the total nitrogen content of stripped apple juice from 6.9 to 1.0 mg. per 100 ml. When the excess acidity is neutralized and the juice concentrated, the resulting concentrate shows a reduced darkening

rate. Ion-exchange may be effectively combined with carbon treatment or ascorbic acid treatment to give concentrates of good color stability. Successive treatment with cation- and anion-exchange materials, followed by restoration of organic acid content and pH adjustment gives concentrates whose color remains almost constant at low and medium temperatures and shows a greatly reduced rate of darkening at high temperature. This treatment gives the best results of all those tried at low and medium temperatures.

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LITERATURE CITED

1. Challinor, S. W., Kieser, M. E., and Pollard, A. Effect of ion-exchange treatment on the stability of apple juice. *Nature*, **161**, 1023-25 (1948).
2. Englis, D. T., and Fiess, H. A. Conduct of amino acids in synthetic ion-exchangers. *Ind. Eng. Chem.*, **36**, 604-609 (1944).
3. Eskew, R. K., Redfield, C. S., and Phillips, G. W. M. High-density, full-flavor apple juice concentrate. U. S. Department of Agriculture, Bureau of Agricultural and Industrial Chemistry, *AIC-315*. (1951). (Processed).
4. Marshall, C. R., and Walklin, A. C. Preparation of full-flavored apple juice with increased resistance to fermentation. *Food Technol.*, **6**, 229-34 (1952).
5. Milleville, H. P., and Eskew, R. K. Recovery of volatile apple flavors in essence form. *Western Canner and Packer*, **38**, 51-54, Oct. 1946.

Effect of Storage Temperature on Quality of Canned Grapefruit Sections[a]

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(Manuscript received November 9, 1954)

Canned grapefruit sections obtained from a commercial plant and stored at various temperatures were examined during storage for color, flavor, firmness and changes in pectin content. Data showing changes over a year's period of storage at various temperatures are presented and discussed.

Commercial citrus processors have found that canned grapefruit sections keep better in warehouses in the San Francisco, California, area than in Florida storage. Temperatures in the California warehouses have been reported by Monroe, Brighton and Bendix *(5)* and Riester, Wiles and Coates *(7)* to be about 10° F. cooler than those in Florida houses. This has created an interest in the economic possibility of lowering the temperatures in Florida warehouses by ventilating, insulating and air conditioning to improve storage conditions and thus preserve product quality.

Except for information on vitamin content *(3, 6, 9)*, very little is available in the literature to show effects of storage conditions on quality; thus the studies reported here were undertaken to determine the stability of grapefruit sections to color, flavor and firmness changes at various storage temperatures.

EXPERIMENTAL PROCEDURE

Preparation of sections. The samples of canned sections used in this study were taken during commercial canning operation in a Florida plant over a 5-day period in January 1953. The canning of grapefruit sections has been discussed by Chace, von Loesecke and Heid *(1)* and Stevenson *(10)*. The procedure used in preparing the pack studied was as follows: Selected seedy grapefruit of sizes 70 to 80 were steam scalded and hand peeled. A lye bath and water spray was then used to remove remaining albedo and segment membrane. Trained employees separated the sections and prepared a pineapple-style pack in steam-cleaned cans. Syrup was added under vacuum, the cans were steam closed, and then the product was pasteurized by passing the cans through a tank cooker in which the water was maintained at approximately 180° F. This heat treatment was sufficient to give a minimum temperature of 160°-168° F. at the center of the can. After cooling to 100° F. in a tank cooler, the cans were labeled and cased, and then transferred to a warehouse storage for a minimum time of 2 weeks to allow "firming up" prior to shipment.

Storage of packs. Two cases (48-cans 303 x 406) of sections were secured from the plant each day for 5 consecutive days to obtain a representative sample. These sections were taken from the 3rd and 4th periods of the work day. They were allowed to firm up in the warehouse for 14 days until transferred to 32° F. storage in the laboratory. Equal numbers of cans of sections from each day's pack were placed at 32° (control), 60°, 70°, 80° and 90° F. storage on March 1, in such a manner that a 5-can sample, consisting of one can from each of the 5 days, could be removed from storage at a given temperature at scheduled examination dates.

Examination methods. A given 5-can sample of sections was opened and placed in a white enameled tray. A panel of 4 people used organoleptic methods to score a sample against a control sample that was stored at 32° F. Samples or sections were rated for flavor, color, and firmness. The changes found in the sections were listed as *none* or 1, *slight* or 2, *marked* or 3, and *extreme* or 4. A portion of the syrup was removed for determination of total acidity, total soluble solids, and pH. Twenty-five of the best sections were removed from the sample and drained on a 6-mesh screen. These sections were comminuted 3 min. in a Waring blender to furnish a slurry for determination of pectin as anhydrogalacturonic acid (AGA) *(2)*, pectinesterase activity *(4)* and color differences. Color differences were determined with a Hunter Color Difference Meter in connection with the development of a photoelectric color grading method.

[a] Cooperative research by the Florida Citrus Commission and Florida Citrus Experiment Station. Florida Agricultural Experiment Station Journal Series, No. 335.

RESULTS AND DISCUSSION

Initial examination. At the beginning of the storage period, single cans from each of the 5 packs were opened and compared. These samples were found to be equal in firmness and color, although one can was found to be rather tart. Some of the small segments were noted as being firmer and more tart than large segments in the same sample. In all cans examined during this investigation, the total acidity (citric) varied from 1.01 to 1.35%. The total soluble solids varied from 17.0° to 19.9° Brix with Brix/acid ratios varying from 14.8 to 16.8. The pH ranged from 3.3 to 3.4.

Flavor. Flavor changes at 3-month intervals at the various storage temperatures are shown in Table 1. The segments stored at 90° F. were markedly different in 3 months and extremely different in 9 months from the control sample. Hydrogen swells developed in the 90° F. samples after 1 year. The 80° F. segments showed marked changes in 9 months, while the samples stored at 70° F. showed only slight changes in 1 year. Samples stored at 60° F. showed little, if any, change in 1 year.

Color. Color changes occurring in the segments are also shown in Table 1. The first browning occurred in the sample stored 3 months at 90° F. The darker color was apparent in the sections and also in the drained syrup. Slight browning occurred in the 80° F. sample in 3 months and was also found in the 70° F. sample after 1 year. Examination of the sections with the Hunter Color Difference Meter showed a color difference in the samples stored at 80° and 90° F. for 6 months. At 12 months, the color meter placed the 60° F. sample with the control, but indicated that the 70°, 80° and 90° F. sections were of a different color.

Firmness. Changes in firmness of the sections are listed in Table 1. Slight changes in firmness were found in the 80° F. and 90° F. samples at 3 months. A slight change was found in the 70° F. sample in 1 year. The firm segments in the 90° F. sample at 12 months were tough and rubber-like while the soft sections were very soft and mushy.

Pectinesterase activity. The enzymic activity of the canned sections expressed as (PE.u.)g. ranged from none to 0.2×10^{-3}, whereas Rouse *(8)* showed fresh Duncan grapefruit juice sacs as having an activity of 39.9×10^{-3}. Thus, it is doubtful if enzymic activity remained in the canned product.

Pectin. Due to the great variation in pectic substances from sample to sample, direct comparison and interpretation of individual results was impossible; however, there appears to be a significant trend when all results obtained from examining 15 samples (5 sample replications at 3-month intervals) over a 9-month period are considered. Table 2 shows the percentage pectin on a wet basis in the water-soluble, polyphosphate-soluble and sodium hydroxide-soluble (protopectin) pectic fractions. The total AGA found was 59.26 mg.; thus any percentage figure shown in the table multiplied by 59.26 would equal the milligrams of AGA found for a particular analysis.

TABLE 1

Changes occurring in canned grapefruit sections during storage

Storage temperature	Flavor				Color				Firmness			
° F.	3-mo.	6-mo.	9-mo.	12-mo.	3-mo.	6-mo.	9-mo.	12-mo.	3-mo.	6-mo.	9-mo.	12-mo.
32	1.0 None	1.0 None	1.0 None	1.0 None	1.0 None	1.0 None	1.0 None	1.0 None	1.0 None	1.0 None	1.0 None	1.3 None
60	1.0 None	1.3 None	1.3 None	1.5 None	1.0 None	1.0 None	1.3 None	1.4 None	1.3 None	1.3 None	1.0 None	1.3 None
70	1.3 None	1.5 None	1.8 Slight	2.5 Slight	1.0 None	1.3 None	1.3 None	2.3 Slight	1.5 None	1.3 None	1.0 None	2.3 Slight
80	1.5 None	2.1 Slight	2.8 Marked	3.8 Extreme	1.5 None	2.3 Slight	2.5 Slight	3.3 Marked	2.0 Slight	2.3 Slight	2.3 Slight	3.3 Marked
90	2.8 Marked	3.5 Marked	4.0 Extreme	4.0 Extreme	2.5 Slight	3.3 Marked	4.0 Extreme	4.0 Extreme	2.3 Slight	3.0 Marked	4.0 Extreme	4.0 Extreme

TABLE 2

Changes occurring in pectic substances in canned grapefruit sections during storage

Storage temperature	Percentage of total pectin [1]											
	H_2O-soluble				$(NaPO_3)_6$-soluble				NaOH-soluble			
	3-mo.	6-mo.	9-mo.	Sub total	3-mo.	6-mo.	9-mo.	Sub total	3-mo.	6-mo.	9-mo.	Sub total
° F.	%	%	%	%	%	%	%	%	%	%	%	%
32	0.88	0.91	0.74	2.53	3.44	3.24	3.11	9.79	3.44	3.17	2.42	9.03
60	0.81	1.05	0.91	2.77	2.84	3.31	3.31	9.46	2.13	2.63	1.85	6.61
70	1.05	0.98	0.98	3.01	3.71	3.38	3.11	10.20	2.84	2.26	2.05	7.15
80	0.98	1.22	0.98	3.18	2.97	3.92	3.58	10.47	1.99	1.88	2.05	5.92
90	1.35	1.49	1.49	4.33	3.71	3.92	4.39	12.02	1.62	0.84	1.07	3.53
Sub totals %	5.07	5.65	5.10	15.82	16.67	17.77	17.50	51.94	12.02	10.78	9.44	32.24
Total %												100.00

[1] Percentage of total pectin in 15 samples examined.

There was an overall trend toward less protopectin with longer storage times or with higher storage temperatures. The 3-month samples had 12.02% of the total AGA. This decreased to 10.78% at 6 months and 9.44% at 9 months. The control samples held at 32° F. for 3, 6 and 9 months had 9.03% of the total as compared to 3.53% in the 90° F. samples.

The water-soluble pectins increased stepwise with increase of storage temperature, and ran from 2.53% at 32° F. to 4.33% at 90° F. A trend did not develop with time of storage.

The polyphosphate-soluble pectins showed the same trend that was found in the water-soluble fractions. The 32° F. samples had 9.79% of the pectins. The percentage increased with temperature to 12.02% pectin in the 90° F. samples.

Because the syrup was drained off and discarded it is probable that some pectic substances were lost. The relationships shown for pectin with respect to temperature and time of storage therefore apply only to the sections at the time of analysis.

SUMMARY

Selected samples representative of a good commercial pack of canned grapefruit segments were stored for one year at carefully controlled temperatures of 32°, 60°, 70°, 80° and 90° F. to determine the rate of degradation of flavor, color and firmness.

After 3 months the flavor in the product stored at 90° F. was found to be markedly different from the control sample stored at 32° F.; color and firmness showed changes in 3 to 6 months. At 80° F. the grapefruit sections were of good quality for 3 to 6 months but showed marked changes in color and firmness and objectionable changes in flavor at 12 months. The 70° F. storage sample showed slight changes after 1 year. Therefore, for maintenance of original good quality in canned grapefruit sections, the products should be held at 70° F. or lower. Marked changes that result in lower quality in this product occurred at storage temperatures of 80° F. or above.

A general trend was noted in the changes in the pectic substances, although there was considerable variation among samples. Protopectin decreased with storage time and with increase of storage temperature. More water-soluble and polyphosphate-soluble pectins were present in the samples held at the higher temperatures.

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LITERATURE CITED

1. Chace, E. M., von Loesecke, H. W., and Heid, J. L. Citrus fruit products. U. S. Dept. Agr., *Circ. 577* (1940).
2. Dietz, J. H., and Rouse, A. H. A rapid method for estimating pectic substances in citrus juices. *Food Research*, **18**, 169 (1953).
3. Krehl, W. A., and Cowgill, George R. Vitamin content of citrus products. *Food Research*, **15**, 179 (1950).
4. MacDonnell, L. R., Jansen, E. F., and Lineweaver, H. The properties of orange pectinesterase. *Arch. Biochem.*, **6**, 389 (1945).
5. Monroe, K. H., Brighton, K. W., and Bendix, G. H. The nutritive value of canned foods. XXVIII. Some studies of commercial warehouse temperatures with reference to the stability of vitamins in canned foods. *Food Technol.*, **3**, 292 (1949).
6. Moschette, Dorothy S., Hinman, Winifred F., and Halliday, Evelyn G. Effect of time and temperature of storage on vitamin content of commercially canned fruits and fruit juices (stored 12 months). *Ind. Eng. Chem.*, **39**, 994 (1947).
7. Riester, D. W., Wiles, G. D., and Coates, J. L. Temperature variations in warehousing citrus juice. *Food Inds.*, **20**, 372 (1948).
8. Rouse, A. H. Distribution of pectinesterase and total pectin in component parts of citrus fruits. *Food Technol.*, **7**, 360 (1953).
9. Sheft, Bernice B., Griswold, Ruth M., Tarlowsky, Elizabeth, and Halliday, Evelyn G. Nutritive value of canned foods. Effect of time and temperature of storage on vitamin content of commercially canned fruits and fruit juices (stored 18 and 24 months). *Ind. Eng. Chem.*, **41**, 144 (1949).
10. Stevenson, A. E. The canning of grapefruit and grapefruit juice. *Ind. Eng. Chem.*, **26**, 823 (1934).

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TENOX II **Application:** Lard, animal fats, vegetable oils, potato chips, spices, cosmetics, nuts.	20		6	4			70
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TENOX VI **Application:** Designed to provide maximum stability to lard under Meat Inspection Regulations. Also useful in stabilizing vegetable oils, potato chips, cereals and nuts.	10	10	6	6	56		12
TENOX VII **Application:** A high concentration of antioxidants dissolved in an extra soluble solvent combination for easy addition where suitable agitation equipment is not available.	28		12	6	20		34
TENOX R **Application:** Tallows and greases for animal feeds.	20			20			60
TENOX S-1 **Application:** Provides high AOM stability. Vegetable oils, potato chips.			20	10			70

Don't let rancidity, bad odor and off-flavor cause returns, losses and dissatisfied customers. Use Tenox antioxidants to protect sensitive foods against oxidative deterioration.

Antioxidants are simple to use . . . inexpensive to use. As their name indicates, they retard the natural oxidative breakdown of fats and oils which in turn causes rancidity. Their value has been proved on a wide range of food products. Every year finds antioxidants playing a bigger role in food protection.

Can antioxidants help you? Call on Eastman if you would like to investigate the use of antioxidants to stabilize your food products. Eastman is the leader in food-grade antioxidants. The leader in volume . . . in experience . . . in accumulated data. Write to Eastman Chemical Products, Inc., a subsidiary of Eastman Kodak Company, Kingsport, Tennessee.

Tenox

Eastman food-grade antioxidants

SALES OFFICES: **Eastman Chemical Products, Inc.**, Kingsport, Tenn.; New York—260 Madison Ave.; Framingham, Mass.—65 Concord St.; Cincinnati—Carew Tower; Cleveland—Terminal Tower Bldg.; Chicago—360 N. Michigan Ave.; St. Louis—Continental Bldg.; Houston—412 Main St. **West Coast: Wilson Meyer Co.**, San Francisco—333 Montgomery St.; Los Angeles—4800 District Blvd.; Portland—520 S. W. Sixth Ave.; Salt Lake City—73 S. Main St.; Seattle—821 Second Ave.; **Canada: P. N. Soden Co., Ltd.**, Montreal, Quebec—2143 St. Patrick St.; Toronto, Ontario—1498 Yonge St.

RECENTLY ELECTED MEMBERS OF IFT

(Continued from page 26 preceding technical papers)

Thomas S. S. Mao
Univ. of Illinois
Food Tech. Dept.
219 An. Sci. Lab.
Urbana, Ill.

Philip T. Phillips
4355 S. Sawyer Ave.
Chicago 32, Ill.

Harold M. Rich
31 Marlboro St.
Boston, Mass.

Richard C. Thorp
1104 W. Main St.
Urbana, Ill.

James L. Vetter
Univ. of Illinois
South Wing, Hort. Field Lab.
Urbana, Ill.

Charles B. Wood
Virginia Polytechnic Inst.
Dept. of Hort.
Blacksburg, Va.

Annual Meeting Bulletin Board

Plans are complete for the Columbus meetings. Almost every phase of the industry is covered in the 128 papers which will be presented. (See *abstracts*, this issue.) All exhibit space has been sold. Entertainment includes the usual features—plus an ox-roast, plus an aquatic show featuring the world's best swimmers and divers. Mike Peppe's team, on March 24-26, captured the NCAA swimming meet with 90 points. Nearest competitors were Michigan and Yale with 51 points each.

Hotel accommodations are the best in the 15-year history of the IFT; over 1000 rooms, many air-conditioned, with 4 meeting rooms each having a capacity of 400 or more. Special rates are available for students, $2.00 per night in Mack Hall on the O. S. U. Campus.

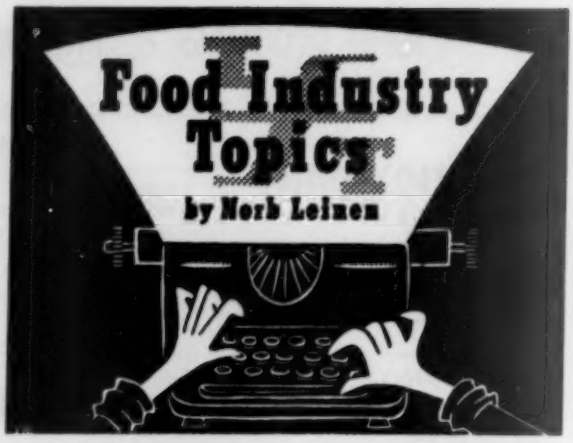
The tours include ultra-modern research laboratories —a diversity of types. You will be able to see how they go about things in the research fields of interest to industry, to a university, and to a non-profit research center—Battelle Memorial Institute. This institute is now installing an atomic reactor which will be used jointly by the institute and Ohio State University.

In and around Columbus you can visit almost any type of food processing plant you desire. A telephone call to the plant you wish to visit will turn the trick.

Registration blanks have been mailed to all members. This includes hotel reservation cards, news of the Convention, a special letter from the Women's Entertainment Committee describing the very excellent ladies' program.

If you failed to get your letter, be sure to write to the General Chairman, H. D. Brown, Hort. Dept., O. S. U., Columbus 10, Ohio. Pre-registration must be completed before May 28. Be sure to pre-register. It will save you a lot of time

Registrations are coming at the rate of 10-20 each day. We anticipate the largest attendance in IFT convention history. There will be 125 committee members on hand in order to make your stay profitable and enjoyable. You have certainly thought of these things but may we remind you that at the convention (1) through the papers, you can obtain a short course, plus consultation, on a problem of your interest, (2) meet promising young candidates for food industry jobs, (3) keep contact with fellow-workers in your field, (4) learn what's new in food legislation, (5) exercise (perhaps develop) your instinct for sociability, and (6) get the feeling of professional fellowship.



. . . in the public interest

Cooperative efforts are under way between food processors and the collapsible metal tube industry to package specialized foods in fold-up metal containers, it was disclosed by Mr. Thos. C. Sheffield of the Collapsible Tube Manufacturers' Council in Los Angeles. He reported tests on a number of foods such as peanut butter, jellies, mustard, catsup, mayonnaise, fish and meat pastes, in collapsible tubes.

◆ ◆ ◆

Calling on his industry for increased effort in 1955, Mr. Geo. H. Coppers, chairman of the Food Division of the Committee of American Industry, opened the Spring appeal of the National Fund for Medical Education by setting forth as a three-point goal: (1) renewal of all 1954 gifts and establishment of such gifts on an annual basis; (2) contributions from all sponsor's companies; and (3) gifts from as many companies as possible in the Food industry. Mr. Coppers emphasized the importance of assuring the schools continued support lest they turn to the federal government for ever-increasing subsidies—in the words of President Eisenhower, "a dangerous alternative." The Fund's address is 2 W. 46th St., New York 36, N. Y.

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The first commercial application of atomic energy to the food field will probably be in the use of low doses of radiation to extend the storage life of plants, meats, dairy products, grains, and baked goods, according to a recent issue of *Radiation Applications*, published by the research and consulting firm of Radiation Applications, Inc., 342 Madison Ave., New York 17, N. Y.

◆ ◆ ◆

Emergency drinking water sealed in metal cans may well become vital to national and civilian defense, reports American Can Co. Although on a limited scale to date, the potential looms quite large should the threat of communist aggression increase. Such a move might well make us dependent upon canned drinking water as one of our most important defensive weapons because sealed tin cans are among the best protections we have against contamination by bacteria

(Continued on page 34)

Doesn't Your Business Deserve the BEST SANITIZING AGENT?

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Reg. U. S. Pat. Off. and Canada

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Roccal is a powerful germicide. In recommended dilutions, it is non-poisonous, non-irritating to the skin, virtually odorless and tasteless.

Roccal can be used for every sanitizing job in processing and packaging in the following food industries: milk, cream, ice cream, butter, cheese, egg breaking, sugar, fish, poultry, fresh frozen vegetables and fruits, meat products, cereal products, candy and beverage, wherever the product comes in contact with equipment. Also to keep walls and floors sanitary.

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Samples and Literature on Request

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Scientifically manufactured MAGNA SPICE CONCENTROLS have modernized the seasoning of meats by making available the true flavor components of herbs and spices in the most concentrated form known to Science . . . yet easily processed in your own plant. All the flavor is released immediately. Each batch of your product is uniformly and identically seasoned.

- Out perform crude herbs and spices.
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FOOD INDUSTRY TOPICS

(Continued from page 32)

or atomic radiation. In addition to the military needs, canned water has been bought by defense-minded civilians through several large department stores in U. S. coastal cities. Hospital and civil defense units have also stored canned water for possible future emergency use since large areas of the country are supplied from surface sources vulnerable to atomic attack. Canco advises that due to probable variations in the original water, canned water should be regarded as a formulated product. Container and packaging procedure must be determined by test packs of each supply of water under consideration.

◆ ◆ ◆

Adoption of standards by the Soft Drink Canners Assn. for the canning of carbonated soft drinks was announced by Mr. Walter S. Mack, president, as a forward step to insure both quality of products and of containers. Mr. Mack pioneered the new industry of canning carbonated soft drinks in 1953. The more than 40 firms which have since entered the field recently formed the new trade association. Headquarters are at 270 Park Ave., New York City.

◆ ◆ ◆

General Foods Corporation gave Rutgers University the $15,000 electron microscope being inspected here at the Rutgers Institute of Microbiology by Dr. Walter A. Maclinn, left, IFT member and chairman of the Food Technology Department at the College of Agriculture, and IFT member Harvey K. Murer, manager of the General Food Corporation's Central Laboratories in Hoboken, N. J. Dr. Norman C. Dondero, Institute cytologist, operates the controls.

◆ ◆ ◆

The dream of fresh milk in cans has been given a boost by scientists at Illinois Institute of Technology, Chicago, who have been working with unique irradiation sources. Approximately 3 billion bacteria per cubic centimeter of milk were destroyed in recent experiments using mercury-in-gas resonance radiation. Ultimately, the scientists hope to evaluate mercury-in-gas resonance radiation on other liquid foods besides milk. Continued research will be necessary in the sterilization of milk.

◆ ◆ ◆

Tuskegee Institute is offering fellowships for research and graduate study toward the M.S. degree in chemistry, foods and nutrition, agronomy, and poultry science, available to students with high scholastic

(Continued on page 36)

Preparation... First step to perfection

Like the diamond cutter and his exacting calculations, Canco exercises meticulous care in every detail of container production.

For you, Canco's relentless effort to produce perfect containers means fewer work stoppages on your production lines, lower packing costs and maximum container efficiency throughout your channels of distribution.

Canco's precise specifications for its containers are arrived at only after exhaustive laboratory tests, pilot-line manufacturing trials and experimental packs. This zeal for container perfection also applies to raw materials, packing—even shipping.

That's why the containers which roll off Canco lines can best take your products to market at a profit.

Go first to the people who <u>are</u> first!

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The modern food can—perfected by Canco—made commercial canning of fruits and vegetables possible; revolutionized the grocery business; helped raise the national level of nutrition and health.

Through the years, constant Canco pioneering and cooperation with the canning industry have brought forth widespread process and product improvement—opening new markets for canned foods of all kinds.

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A highly suitable line of dry flavors for use in DRY-MIXES, such as: Gelatin desserts, pudding powders, beverage powders, sherbet mixes, pie-filling powders, etc.

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Superb in taste and Keeping properties

FOOD INDUSTRY TOPICS

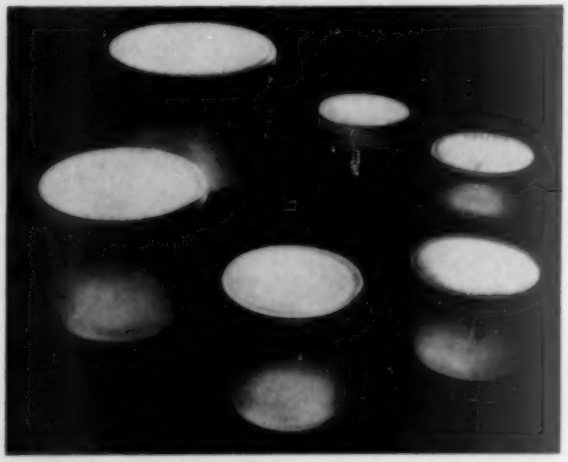
(Continued from page 34)

records who have received the B.S. degree from an accredited college and who show promise of research ability. Stipends range from $1200 to $1500 annually. For further information address: Director, The Carver Foundation, Box 188, Tuskegee Institute, Alabama.

◆ ◆ ◆

The Food and Nutrition Board moved recently to activate a standing Committee on Amino Acids to evaluate their possible usefulness as food additives. With the quantity and quality of protein available in the U. S., there appears no need for amino acid supplementation. However, more data are needed on amino acid content of typical foods to determine whether the U. S. dietary is adequate in certain amino acids. The Human Nutrition Research Branch, Agricultural Research Service, is continuing to collect available data. Laboratories having original data are encouraged to communicate with Dr. Esther Phipard, Human Nutrition Research Branch, U. S. Dept. of Agriculture, Washington, D. C. Expression of values in terms of milligrams of amino acid per 100 grams of food, together with total nitrogen content of the food is desired.

. . . things new under the sun



From the 6-ounce midget, through the 8-, 12-, 16-, and 32-ounce sizes, up to the 64-ounce giant, these low-cost unbreakable polyethylene "Seal-Tainers" with the exclusive lock-tight, spill-proof lid are boosting impulse sales. Food, ice cream, dairy, drug, cosmetic, and allied products get full area visibility at about one-sixth the weight of glass. Re-use value of Seal-Tainer increases product acceptance, stimulates repeat sales. Manufactured by Plastomatic Corp., Malvern, Pa.

◆ ◆ ◆

Many of the difficult problems in the accurate weighing and handling of multiple ingredients have been easily solved by introduction of a **new application of weight control** claimed to increase production, lower costs, and turn out a consistently better product, in contrast with the slower and oftentimes inaccurate hand - weighing - transporting method employed in many industries. For further information on this automatic weighing method, write Link Engineering Co., c/o William Hart Adler, Inc., 726 Lothrop, Detroit 2, Mich.

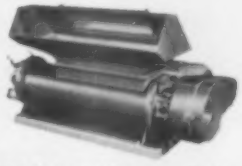
(Continued on page 38)

Best for Every Tomato Product...

fmc SPECIALIZED TOMATO PREPARATION & PROCESSING EQUIPMENT

If you pack any tomato products, you are probably operating some of the FMC tomato equipment described here. For there is an FMC *Specialized* item for practically every stage in the preparation and processing of tomatoes and all tomato products. Each is engineered and built to meet the most exacting requirements, and to deliver highest quality products at lowest operating, maintenance and replacement costs. For the best in equipment for every tomato product, specify FMC—your key to Food Equipment.

FMC Pulpers and Finishers—Heavy duty frame, rigid construction. High capacities: Pulpers 5 to 20 tons per hr. Finishers 20 to 100 GPM.



FMC Tomato Chopper—Delivers small uniformly chopped product at 25 tons per hr. Table-level feed height eliminates feed elevators.

FMC Hand Pack Filler—Sturdy stainless top. Constant or variable speed drive. Sets the pace for your tomato line.

FMC Juice Processor—Continuous preheating, pasteurizing, holding and cooling in one machine. Capacities: 20-70 GPM. 1, 2 and 3-Unit Processors also available.

FMC Tomato Lines—Thorough washing, sorting and scalding on a continuous conveyor. Available in high or low pressure water systems.

FMC Flood Washer—Provides a gentle yet thorough washing action through low pressure spraying and flooding.

FMC Juice Extractors—Large screen area, extra long screw and extraction area for capacities up to 75 GPM. Lower capacity models available.

OTHER FMC TOMATO EQUIPMENT

- Rotary Washers
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- Scalders
- Fillers (Juices, pastes, solids)
- Heating coils and stainless steel tanks
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- FMC Atmospheric Cookers and Coolers.

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Canning Machinery Division

General Sales Offices:

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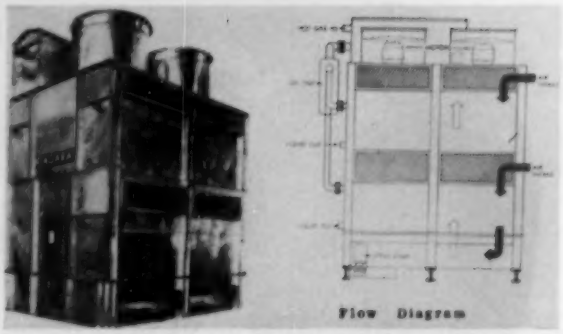
FOOD INDUSTRY TOPICS

(Continued from page 36)

Mutual Citrus Products Co., Anaheim, Calif., announced it has secured a patent (No. 2,540,050) entitled "Enzymatic Methods of Making Pectin Preparations" which, as the title shows, uses the enzyme pectase to produce a **new type of pectin** that requires less, little, or no sugar at all to function. This pectin is now being offered under the brand name M. C. P. "Low Sugar" Pectin. It requires only fruit juice and fruit acids to make jellies. Sugar is used only as a flavoring ingredient. To make fruit acids available, M. C. P. recommends use of lemon juice, which is also rich in vitamin C, for extra health benefits.

◆ ◆ ◆

Development of a **unique cellular glass insulating material** which combines both insulation and ceramic finish in a single unit has been announced by Pittsburgh Corning Corp. Called "Duraface Foamglas," the completely inorganic material provides a durable, chemical- and impact-resisting surface along with high insulating and moisture-proof qualities. With the new material, a wall completely insulated and surface-finished can be erected in one operation. No finish coating is required to protect the insulation. Unsupported walls can be built of the blocks because of their rigidity and high compressive strength. Write Pittsburgh Corning Corp., c/o Ketchum, MacLeod & Grove, Inc., 411 Seventh Ave., Pittsburgh 19, Pa.



A new 200-tons-refrigeration-capacity AMMONIA CONDENSER has been added to its line of high-capacity industrial and commercial refrigeration installations of from 10 to 400 tons in single units of convenient size by Niagara Blower Co., 405 Lexington Ave., New York 17, N. Y. A patented feature, a reverse-direction air stream, increases the unit's capacity and greatly reduces electric power outlay. The spray water falls into a tank at base of unit and is recirculated, with a net water consumption of less than 5% of the water used by submerged coil-type condensers of equal capacity. The equipment is protected from freezing. The condenser measures 8½ feet x 14 feet x 16 feet high, and weighs approximately 13 tons.

◆ ◆ ◆

A tank cleaner providing 3-dimensional rotation of a high pressure hydraulic jet is announced by Sellers Injector Corp., Philadelphia, Pa. Designated the Rotor Jet, the compact, lightweight device delivers 2 powerful streams of water over the entire inside surface of tanks of any shape. Portability enables one man to handle the entire tank cleaning operation. Available in 3 models for discharge capacities from

(Continued on page 40)

ACCESSORY NUTRIENT FACTORS

For the luxuriant growth of all lactic acid bacteria yeasts and molds assured by the use of

EXCHANGE BRAND ORANGE SERUM AGAR #77

(Dehydrated) a Complete Culture Medium

FORMULA		
Ingredients—when rehydrated on basis of 45 grams per liter of medium.	Orange juice serum solids	12.6g*
	Agar (dry basis)	15g
	Peptone	10g
	Yeast hydrolysate	3g
	Reducing sugars, total	8g
	Sucrose, total	6g
	Cysteine hydrochloride	0.001g

Buffered with 0.2 to 0.6g K_2HPO_4 to provide pH 5.5 ± 0.05 after sterilization.

** Equivalent to 100 ml 12° Brix orange juice serum.*

STANDARDIZED for uniformity and stability.

POTENTIAL APPLICATION—Orange Serum Agar as an all-purpose medium has a wide application to the bacteriologist and microbiologist in the milk, fruit pickling, food, bottling and fermentation industries.

Available in 1 lb. bottles through your laboratory supply house.

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Another highest-accuracy control instrument from the most complete line serving industry.

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- **LOWERS CONTROL COSTS!** This low-priced instrument releases expensive full-range units for other jobs. Trouble-free design protects vital parts from heat, dust, fumes, stray liquids . . . ensures minimum maintenance, maximum use.

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SINCE 1853

America's only complete optical source . . . from glass to finished product.

FOOD INDUSTRY TOPICS

(Continued from page 38)

600 to 6000 g.p.h. Write for Bulletin 431 to Sellers Injector Corp., 1601 Hamilton St., Philadelphia 30, Pa.

◆ ◆ ◆

A process of homogenizing chocolate masses in a matter of seconds with an ultrasonic conche, resulting in savings while improving the flavor of the product, and an ultrasonic hops extractor that improves the flavor and quality of beer while cutting production costs are offered by the Curtiss-Wright Corp., Wood-Ridge, N. J. The devices are 2 of a series of new Curtiss-Wright products in the fields of ultrasonics, electronics, and plastics.

◆ ◆ ◆

Recently announced by Alupharm Chemicals, 54 C St., Elmont, L. I., N. Y., are 3 types of **ready-to-use aluminum oxide absorbents** for chromatography—acid, non-alkaline (neutral), and basic—possessing Grade I Surface Activity (Brockman) and constant properties. The firm says these oxides—developed by M. Woelm of West Germany—facilitate and expand use of alumina in chromatographic analysis. Write for brochure.

◆ ◆

A line of **sealed solenoid-operated air valves** that are moisture-proof, dirt-proof, and dust-proof is offered to plants where grit, oil, coolant, or other moisture interferes with air valve operation. Specification sheets are available from Mechanical Air Controls, Inc., 10030 Capital, Oak Park, Detroit 37, Mich.

◆ ◆ ◆

Freedom from sticking combined with greater ease of application is assured by Slipicone Spray, made by Dow Corning Corp., Midland, Mich. Unaffected by temperatures ranging from minus 40 to over 400° F., Slipicone forms a pure silicone parting surface that prevents adhesives, foods, paints, plastics, and waxes from sticking to metal or glass surfaces. One quick spray effectively coats hard-to-reach parts, minimizing cleaning time and increasing production. Available from paper and packaging supply houses at prices in the range of $2.00 per 12-ounce container.

◆ ◆ ◆

A new Model 146 Flame Photometer, styled for maximum ease of operation and performance, announced by The Perkin-Elmer Corp., Norwalk, Conn., incorporates features that permit simple and precise read-out of data, enabling a relatively inexperienced operator to turn out accurate determinations over long periods with minimum fatigue. Time for analysis is less than one minute per element with accuracy of ± 1%. Better than this is possible with time and care. A sample size of 2 to 5 cc. is sufficient for an

(Continued on page 42)

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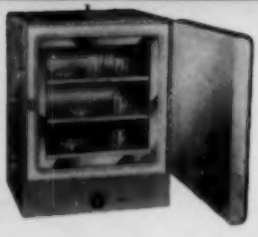
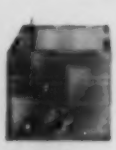
BUY LABLINE

LAB-ROOMS
40° F. to 140° F.


RADIANT WALL OVENS

ALUMALOY CLAMPS


WATER BATHS

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gives finer flavor...
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You get the direct and authentic reproduction of raspberries in their full perfection in Raspberry Flavor by Firmenich. For Firmenich took fully ripe raspberries, freshly severed from the stem, captured their delicate and fugitive flavor, and by original research reconstructed it in all its significant and desirable components. Firmenich Raspberry comes to you as a precise and potent flavor material of the utmost purity and stability to enhance the flavor of your products and to make them more attractive to your customers.

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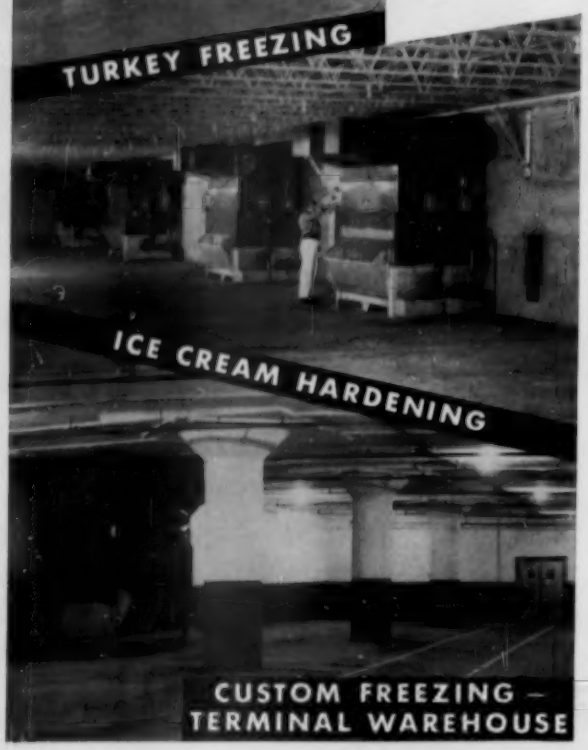

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District Engineers in Principal Cities of United States and Canada

FOOD INDUSTRY TOPICS

(Continued from page 40)

analysis in solution on sodium, lithium, potassium, magnesium, calcium, strontium, barium, chromium, and manganese.

◆ ◆ ◆

Completion of a revolutionary **all-plastic truck body** for the Carnation Milk Co., Los Angeles, is announced by Strick Co., Whitaker Ave. at Godfrey, Philadelphia 24, Pa. Made from a new kind of reinforced fiberglass called "Lamicor," the body consists of 2 halves joined by a neoprene gasket. Lamicor is said to be one of the rare materials that has structural strength as well as thermal insulating properties.

◆ ◆ ◆

A new clamp, designed to hold rubber stoppers firmly in place has been developed by Central Scientific Co., 1700 Irving Pk. Rd., Chicago, Ill., for use on 5-gallon or other bottles that take a 2½-inch stopper. The clamp has applications for transferring solutions by air pressure to other containers, for culture growth under an atmosphere other than air, for storage container of solutions, or as a "C" clamp to hold flat objects in place for cementing. Prices are $5.00 each, $4.50 each in lots of 12, $3.75 each in lots of 36, or $2.75 each in lots of 72.

◆ ◆ ◆

The new Electro Model 3400-A **voltage amplifier** will be useful in industrial automation. Made by Electro Products Laboratories, 4503 N. Ravenswood Ave., Chicago 40, Ill., it is designed to boost voltage of low-output transducers. It also may be used as an all-purpose laboratory-type voltage amplifier. Distortion is less than 2½% up to 10 volts, 6% up to 30 volts — saturation is over 50 volts. The unit sells for $34.50.

◆ ◆ ◆

Odorless paints with excellent resistance to acids, alkalies, and cleansing agents have been perfected by Prufcoat Laboratories, 50 E. 42nd St., New York 17, N. Y. Especially important to food and process industries, Prufcoat's new development may be used without interference in plant operations. With their low temperature resistance, the paints are also ideal for use in cold storage and refrigerator areas which present special problems in vapor and odor removal.

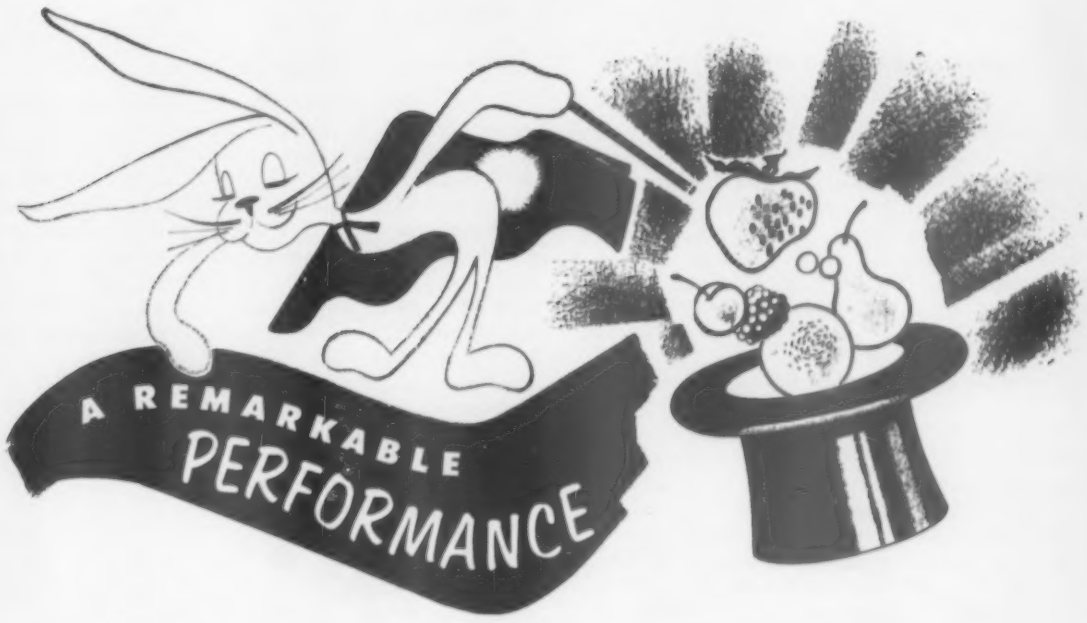
◆ ◆ ◆

A sturdy steel cabinet with 8 crystal-clear "See-Thru" drawers will answer many small-parts storage needs, according to General Industrial Co., 5738 N. Elston Ave., Chicago 30, Ill. Adjustable crosswise and lengthwise dividers make it possible to set up various-sized compartments in the drawers which measure 5⅞" long x 2¾" wide x 1 1/16" high. Complete cabinet is $4.25 postpaid, and is described, along with larger models, in Catalog No. 25.

◆ ◆ ◆

For treatment of water to produce a **controlled degree of hardness,** rather than complete softness, Gra-

(Continued on page 44)



★ The SEALVA process hermetically seals flavors, even those with the most fugitive and delicate components, against the deteriorating effects of aging and oxidation. Droplets of liquid flavor are completely sealed in an inert, edible gum film forming a dry powder of controlled particle size. The completely protected flavor is released only in the mouth or in water.

SEALVA flavors, introduced 2½ years ago, have been enthusiastically accepted in almost every branch of the flavored goods field.

In GELATIN DESSERTS, far superior flavor quality is possible without regard to aging. In CONFECTIONS of the pressed type, flavor permanence is assured. In MIXES and DESSERTS, problems of oxidation and terpenization no longer exist. As DAIRY MIXES, SEALVA flavors offer unbelievable possibilities. In PHARMACEUTICALS SEALVA flavors find their widest acceptance.

Wherever permanent flavor perfection is desired in dry form, SEALVA is the answer.

Tell us your product, your problem. Send for samples and literature.

VAN AMERINGEN-HAEBLER, INC.
521 West 57th Street, New York 19, N. Y.

★ Av FLAVORS

FOOD INDUSTRY TOPICS

(Continued from page 42)

ver Water Conditioning Co., 216 W. 14th St., New York 11, N. Y., offers an effective zeolite bypass. This system controls the proportionate mixing of untreated hard water and treated, fully-softened water to produce degree of hardness desired. Among uses are controlled-scale corrosion prevention, municipal water supply, and wherever it is preferable to use simple zeolite softening without producing a zero-hardness water.

◆ ◆ ◆

A high-pressure hydraulic hose designed to operate at 3000 psi and at temperatures never before demanded in hydraulic systems has been announced by Resistoflex Corp., Belleville, N. J. Because of its complete chemical inertness, the new line, Fluoroflex-T YR700 hose, will reportedly withstand all presently known synthetic or petroleum-based hydraulic fluids, as well as those which may yet be developed, at temperatures over 400° F. Hose sizes available for field testing in ⅜" and ½" sizes; soon to be available are ¼", ⅝", and ¾".

◆ ◆ ◆

In case of power failure this unit will provide maximum protection and sufficient illumination to carry on operations for many hours. Furnishes instant light without touching a switch if regular power fails. Lights are sealed beam of 100 C.P., and provide 10 hours of light. Plugs into any A.C. circuit. Price of the Model E unit is $120.50 complete. For complete information or trial order write: General Scientific Equipment Co., 2700 W. Huntingdon St., Philadelphia 32.

◆ ◆ ◆

Polak's Frutal Works, Inc., Middletown, N. Y., has completed arrangements with Knouse Food Cooperative, Inc., Peach Glen, Pa., for exclusive sales rights on Knouse's Apple Essence 150 Fold. Polak's has also developed an essence with twice this concentration —Apple Essence 300 Fold—and an entirely new product based on these essences—Apple Flavor Wonf 750. The products are recommended for sirups, sauces, jellies, pies, and juices, but not for hard candy or gelatin desserts.

◆ ◆ ◆

G-S No. 32 caps keep female employees' hair out of moving machinery. Cool enough to prevent waves from coming out, the caps are washable, sturdy enough for continuous use, inexpensive, and adjustable to all head sizes. Processed from a vegetable fibre product, they will not dissolve in water or live steam and can be autoclaved or sterilized in boiling water. Caps are securely finished with an elastic to fit all head sizes. Prices range from less than 10c for an individual cap to $59.90 for 1,000 quantity. For complete information or trial order, write General Scientific Equipment Co., 2700 W. Huntington St., Philadelphia 32, Pa.

. . . *the literary corner*

Publication of abstracts of the 174 theses accepted for the doctor's degree at Massachusetts Institute of Technology between September 1952 and July 1953 has been announced by the M. I. T. Office of Publications, Cambridge 39, Mass. The 276-page paper-bound book, available at $2.50, also lists titles of theses presented for engineer's and master's degrees in the academic year 1952-53. Among abstracts included are those of theses in Departments of Chemical Engineering, Chemistry, Civil and Sanitary Engineering, and Food Technology. Microfilms or photoprints of each complete thesis text may be ordered from M. I. T. by reference to the publication. Offset copies of the engineer's and master's theses also are available on a similar basis.

◆ ◆ ◆

The whimsical illustration above is taken from a little folder produced by Food Research Laboratories, Inc., 48-14 33rd St., Long Island City 1, New York, promoting the firm's reliable vitamin D assay service. "For $35.00 . . . all costs included," runs the message, "we will make arrangements for sample pickup, perform the assay by the official procedure, and mail the reports to you and to others as requested." Fair enuf!

◆ ◆ ◆

Increasing consumption of macaroni and noodles in the U. S. has prompted a study of the nutritive quality and versatility of these basic food products. These are revealed in the new Hoffmann-LaRoche brochure, "Enriched Macaroni," which should enable nutritionists, dieticians, food managers, and others to see new horizons in dietary planning. For copies, write Hoffmann-LaRoche, Inc., Roche Park, Nutley 10, N. J.

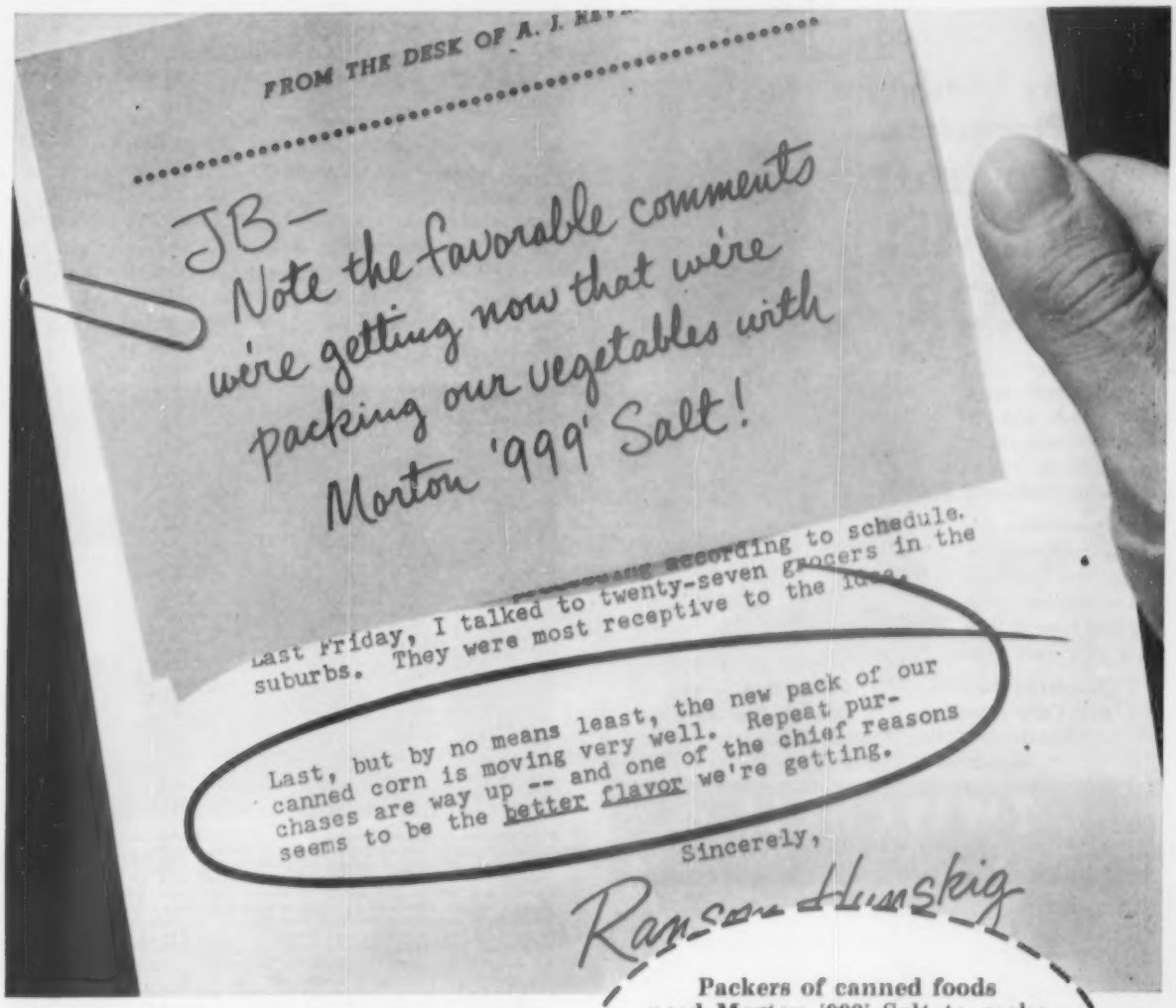
◆ ◆ ◆

A Catalog of Devices Useful in Automatic Data Reduction, listing available automatic data recording equipment essential to widespread use of automation, has been compiled by electrical engineers at Armour Research Foundation of Illinois Institute of Technology under Air Force sponsorship. Contains operation and manufacturers' specifications of 70 data recording instruments. Write Technology Center, Chicago 16, Ill.

◆ ◆ ◆

Facts for Industry, a British monthly information service designed to assist its subscribers to keep in touch with developments in industry, research, technology, management, and marketing, aims "to provide an alert and discriminating service which will supple-

(Continued on page 46)


FROM THE DESK OF A. J.
JB—
Note the favorable comments we're getting now that we're packing our vegetables with Morton '999' Salt!
according to schedule.
Last Friday, I talked to twenty-seven grocers in the suburbs. They were most receptive to the idea.
Last, but by no means least, the new pack of our canned corn is moving very well. Repeat purchases are way up -- and one of the chief reasons seems to be the better flavor we're getting.
Sincerely,
Ransom Hunskig

Packers of canned foods need Morton '999' Salt to make sure of good flavor and prevent quality variations. So do makers and processors of candy . . . beer . . . cereals . . . seasonings . . . meat . . . malted milk . . . mayonnaise . . . margarine . . . sauerkraut . . . olives.

MORTON '999' SALT insures uniform quality in processed foods for two reasons. It's guaranteed to contain more than 99.9% pure sodium chloride—*always!* The 0.1% (or less) is a neutral inert sodium salt—never bitter calcium or magnesium compounds.

Vacuum pan evaporation assures that this salt will be clean . . . free-flowing . . . evenly soluble. It has a constant weight per volume ratio . . . won't pack down.

For further details, mail coupon today! ▶▶

NOTE TO ALL CANNERS: Morton can also provide **BULK SALTING MACHINES** and **SALT TABLET DEPOSITERS** which enable you to get the correct amount of salt into every can... time-saving and labor-saving **BRINE-MAKERS** which deliver saturated, high-purity brine anywhere in your plant. Get the full details on these, too!

MORTON '999'

THE SALT THAT CARRIES ITS OWN GUARANTEE

MORTON SALT COMPANY
Industrial Division — Dept. FT-5
120 So. La Salle Street, Chicago 3, Illinois

☐ **Without obligation, please have a representative call with information on Morton '999' Salt and methods of using it in my product.**

Please send me more information on the
☐ **Bulk Salter** ☐ **Salt Tablet Depositer** ☐ **Brinemaker.**

Name_____

Title_____

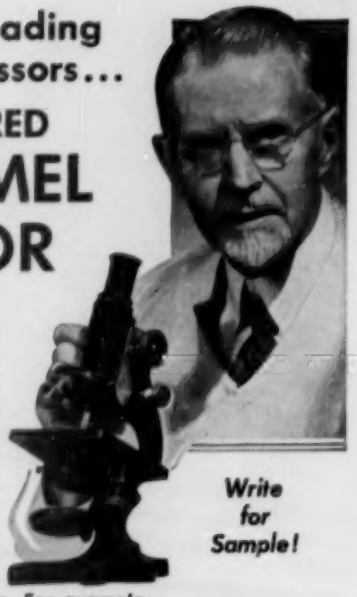
Company_____

Address_____

City_____ Zone____ State_____

Used by Leading Food Processors...

POWDERED CARAMEL COLOR



A dehydrated food color, made entirely from dextrose sugar by cooking under controlled conditions.

It has particular use in dry food products where the use calls for a natural color ranging from a light to a very dark brown. For example:

Write for Sample!

Powdered Desserts *Dehydrated Soups*
Dry Cake Mixes *Bouillon Powders*
Powdered Coffee & other beverages
Powdered Gravy Seasonings

S. TWITCHELL CO.
CRESTMONT & HADDON AVES. • CAMDEN 4, N.J.

FOOD INDUSTRY TOPICS

(Continued from page 44)

ment the larger firm's own intelligence department and give the smaller firm many of the benefits of such a department." Number of journals regularly scrutinized is 280, including those in food and agriculture; chemicals, oils, plastics; packaging; marketing, and distribution. Many American publications are included. For information write A. E. Blake, Calderwood North, Wilmerhatch Lane, Epsom, Surrey, England.

◆ ◆ ◆

Collective Volume III of the well-known *Organic Syntheses* series was published in March by John Wiley & Sons, 440 Fourth Ave., New York 16, N. Y. Edited by E. C. Horning, the book encompasses all material in Annual Volumes 20-29, revised and brought up-to-date with new and improved methods of preparation. Comprising 890 pages, it is priced at $15.00.

◆ ◆ ◆

"Marinite for Driers, Ovens, Breechings and Housings" is a new 16-page, illustrated booklet issued by Johns-Manville, 22 E. 40th St., New York 16, N. Y. It gives complete information on this structurally strong sheet material which both builds and insulates. Included are handling and working recommendations, construction and fabrication suggestions, data on physical and thermal properties, and many in-use photographs.

◆ ◆ ◆

Market Report for March 1, 1955, published by F. Ritter & Co., 4001 Goodwin Ave., Los Angeles, Calif., contains information on the firm's Cyclorome-10, a pure aromatic ketone. This stable solid with high melting point is reported as indispensable in the production of fine maple, butterscotch, caramel, licorice, and nut flavors. It improves baker's vanilla, and, being heat-resistant, stabilizes other flavors. Priced at $18.00 per pound.

◆ ◆ ◆

Telephone relay manufactured by the Stromberg Carlson Corporation is adjusted with the aid of a Bausch & Lomb stereomicroscope. In addition to use in such vision-aiding tasks in the metal working and electronics industries, the instruments are widely used by food, drink, tobacco, and textile processors to detect impurities and imperfections. Magnifications produced by stereomicroscopes range from 6 to 150 diameters, depending on working requirement, and prices range from $222 to $743. A handsome, 36-page brochure on this line of instruments, Catalog D-15, may be obtained without charge from Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N. Y.

◆ ◆ ◆

A completely revised, comprehensive bibliography of the literature on G-11 (Hexachlorophene) has been published by Sindar Corp., 330 W. 42nd St., New York 36, N. Y. This bibliography, Technical Bulletin H-1, dated March 1955, contains references and abstracts of 136 scientific and trade articles, and abstracts of 19 patents, both foreign and domestic.

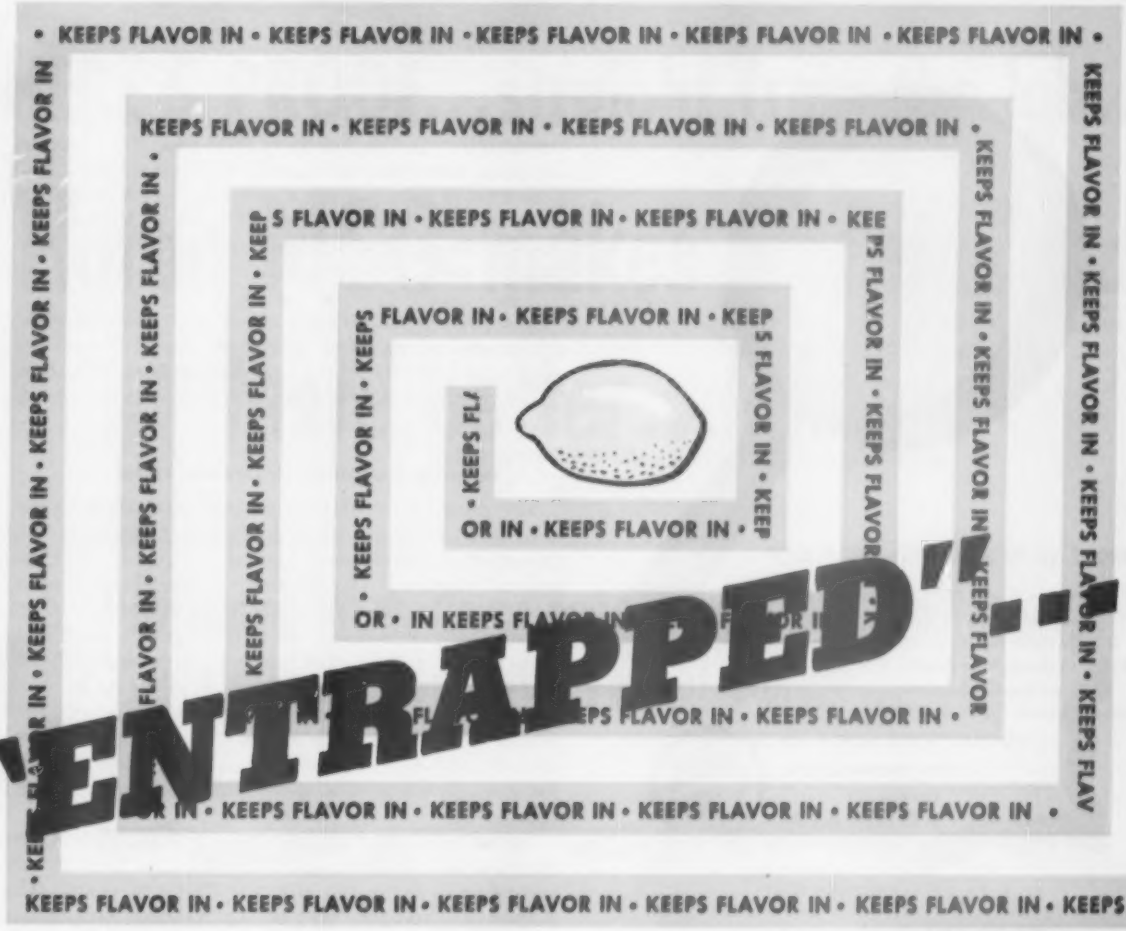
◆ ◆ ◆

Entitled "For the Canning Industry," the newest brochure from Dodge & Olcott, Inc., 180 Varick St., New York 14, N. Y., is set up in 8½ x 11" file folder form for easy cataloging and reference. Contents include history and development of the canning industry, review of the role seasonings and flavors have played, listings of the various groups available and a prediction for future development, and 19 pages of formulae and technical data for canned items. The back of the 40-page brochure features a specially annotated bibliography of books on the canning industry. Free copy available.

◆ ◆ ◆

Proceedings of the one-day Conference on Safety of Packaging Materials held by Packaging Institute at Hotel Biltmore, New York City, on January 12, 1955, have been published. The 24-page volume, at

(Continued on page 48)



. . . more than the eye can see . . . or the superficial taste reveal . . . is the new perfection of Florasynth's controlled "ENTRAPPED" Powdered Flavors that keep the essential qualities within the flavor particles, so alive, so safe . . .

Instantly soluble in cold water . . . an amazing degree of dispersibility within the mix . . . definitely longer shelf-life are among its proved remarkable advantages . . .

FLORASYNTH'S Imitation Flavors are endowed with this quality of "ENTRAPPED" . . . Whichever your choice . . . ORANGE, LEMON, STRAWBERRY or any of the others of our outstanding flavor list . . .

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CYCLOROME-10 MAGNIFIES ANY FINE FLAVOR

Cyclorome-10 is a pure aromatic ketone. Indispensable to intensify and stabilize fine flavors. Heat resistant. Completely soluble in propylene glycol. Use up to 10% in maple, butterscotch, and caramel flavors. Price: $18.00 per lb.

Dr. Alexander Katz Co.
Division of
F. RITTER & CO.
Los Angeles 39, California
Branch Offices in Principal U.S. and Foreign Cities

FOOD INDUSTRY TOPICS

(Continued from page 46)

$2.00 a copy, is a non-technical review of the problems of safety of packaging materials, both legal and scientific, from the viewpoint of users and suppliers. The volume is reported particularly helpful for anyone concerned with past or potential legislative attempts to impose further safeguards on Section 402(a)6 of the Food, Drug and Cosmetic Law. Write Packaging Institute, 342 Madison Ave., New York 17, N. Y.

The Packaging Institute also announces that its executive director since 1947, Dr. L. V. Burton, retired from active direction on March 1, 1955. He will remain on the staff as a part-time consultant in charge of editorial activities. Mr. Chas. A. Feld, associate director since November, 1954, has assumed the administrative responsibilities.

◆ ◆ ◆

Helpful tips on ways to apply economical and efficient air conditioning to more than a score of different types of buildings are outlined in a new Du Pont booklet. Entitled "Guideposts to Better Air Conditioning Installations," 36-page Booklet A-8726 is a compilation of semi-technical articles by outstanding engineering consultants. Contact Mr. F. R. Zumbro, 6529 Nemours Bldg., Wilmington, Del.

◆ ◆ ◆

Food Facts, a new monthly newsletter for the food industries issued by Foster D. Snell, Inc., 29 W. 15th St., New York 11, N. Y., has become a favorite for those interested in keeping up with developments in the food industries. Each issue contains an article of timely interest. The February 1955 issue, for example, discusses packaging and product requirements. Also presented is information which may improve market trading — taken from Snell's *Chemical Market Abstracts*. *Food Facts* is available free to those interested by writing the company.

◆ ◆ ◆

A 4-page brochure illustrating and describing the advantages of liquefied petroleum gas (LP gas) for industrial fork lift trucks is available from Industrial Truck Division, Clark Equipment Co., Battle Creek, Mich.

. . . meeting hall and conference room

The growing importance of public relations to successful development of new chemical products was discussed at the eleventh annual meeting of the Commercial Chemical Development Assn., Hotel Statler, New York City. Speakers told how PR techniques can assist company research and development programs, help launch and market new products, and serve to inform the public of major developments. At the banquet, Mr. Nolan B. Sommer, CCDA president, presented the Association's award of honor to Mr. Kenneth R. Brown, vice president, Atlas Powder Co., for his work in commercial development of sorbitol.

◆ ◆ ◆

Dates for the World Plastics Fair and Trade Exposition have been changed from April to October 5-9, according to exposition director Philip M. Kent. The Exposition hall will still be the National Guard Armory in Los Angeles. Details are available from Consolidated Advertising Directors, 8762 Holloway Dr., Los Angeles 46.

◆ ◆ ◆

Under the leadership of Engineers Joint Council, a dozen organizations, representing more than 250,000 American scientists, engineers and industrialists, announce a Nuclear Congress and Atomic Exposition to be held December 12-17, 1955, in Cleveland. The Congress is the biggest single project yet undertaken by the nation's combined engineering societies. In addition to covering interrelations of all branches of nuclear sciences and engineering, both events have the active support of private enterprise and Government in the power and other atomic fields. Basic objective is to launch a continuing program of interchange of information on developing applications of nuclear science by the engineer for national benefits involving industry, agriculture, medicine, and public welfare. Contact Mr. Athel F. Denham, Atomic Exposition, 931 Book Bldg., Detroit 26, Mich.

◆ ◆ ◆

Mr. Wm. H. Hottinger, Jr., Bowey's, Inc., Chicago, president of the Flavoring Extract Manufacturers' Association of the United States, announces the 46th Annual Convention at the Edgewater Beach Hotel, Chicago, May 23-25. Outstanding speakers will address the meetings, and a symposium will be conducted by the Association's Scientific Research Committee. Contact IFT member Mr. E. N. Heinz, convention

(Continued on page 50)

HERE'S PROOF...straight from the lab...

Huron MSG makes frozen food taste better...longer

"by adding MSG, flavor can be improved...improvement still apparent after year of storage..."

DEPARTMENT OF FOOD TECHNOLOGY
University of Massachusetts

Two points—revealed by scientific flavor tests at the University of Massachusetts—make Huron MSG a must for your frozen food.

2 to 1 consumer preference in over half the taste tests was definitely established for MSG-treated frozen foods.

After 12 months' storage the improvement in flavor of MSG-treated frozen foods was still sharply apparent.

How Huron MSG saves you money

Spot Warehousing. Huron MSG opens this door to volume chain store sales by insuring that your product keeps its "pack-day" flavor in storage.

Sell or Hold. Huron MSG's ability to maintain superior flavor in storage lets you "hold" products when prices are temporarily depressed, sell when prices are right.

Peaks and Valleys. With flavor maintained by Huron MSG you can up your maximum inventory limits considerably, and also avoid costly stop-and-go production.

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PURE MONOSODIUM GLUTAMATE 99+%

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FOOD INDUSTRY TOPICS

(Continued from page 48)

chairman, at Food Materials Corp., 2521 W. 48th St., Chicago, Ill.

◆ ◆ ◆

The first annual Pickle Fair will be held in Chicago on October 19-21, 1955. The "midway" will consist of exhibits of various types of mechanical devices dedicated to the pickle. Seminars, panel discussions, speeches, and a colorful Ball are among other highlights.

◆ ◆ ◆

The Third International Bread Congress will be held from May 31 to June 3 at Hamburg, Germany. Sections are devoted to Nutrition Physiology and Feeding Stuffs, Grain Breeding and Standardization, Analytical Methods, Grain Storage and Milling Technology, Hard Wheat Milling and Hulling Industry, and Baking Technology. American participants include Dr. J. A. Shellenberger, Kansas State College; Dr. L. Zeleny, USDA; Prof. A. M. Schlehuber, Oklahoma A. & M.; Dr. Betty Sullivan, Russell Miller Milling Co.; Dr. M. Milner, Kansas State College; Dr. W. F. Geddes, University of Minnesota; and Dr. C. C. Fifield, USDA. To make last-minute arrangements cable: 3rd International Bread Congress, Sagebiel's Etablissement, Hamburg 36, Am Karl-Muck-Platz, Germany.

◆ ◆ ◆

A society has been formed to further all phases of infrared spectroscopy. Named the "Coblentz Society" in honor of Wm. W. Coblentz, retired chief of the Radiometry Section of the National Bureau of Standards and pioneer in infrared spectroscopy, the Society's object is to foster the understanding and application of infrared spectra, and provide a communication center and voice for the thousands of industrial chemists, scientists, research workers, and teachers who use infrared spectroscopy. Address Dr. V. Z. Williams, registrar, c/o The Perkin-Elmer Corp., Norwalk, Conn., and enclose one dollar to cover enrollment fee.

◆ ◆ ◆

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

1955	
May 15-19	Annual Meeting of the Association of Cereal Chemists, Chase Hotel, St. Louis, Missouri
May 22-25	Flavoring Extract Manufacturing Association, Edgewater Beach Hotel, Chicago, Illinois
May 22-26	International Bread Congress, Hamburg, Germany
May 23-25	Ninth National Convention, American Society for Quality Control, New York City
June 5-9	National Confectioners Ass'n of the U. S. Conrad Hilton Hotel, Chicago, Illinois
June 6-10	American Medical Association, Atlantic City, New Jersey, Traymore Hotel
June 8-10	Eighth Annual Meeting, Research and Development Associates, Food and Container Institute, Inc., Chicago, Illinois (together with Radiation Sterilization of Foods Symposium, June 10, 1955).
June 12-16	**Institute of Food Technologists, Deshler-Hilton Hotel, Columbus, Ohio**
June 20-23	American Dairy Science Association, June 20-23, East Lansing, Michigan

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)

Guests of The Foxboro Company, Foxboro, Mass., during a 3-day instrumentation forum recently conducted at the firm's training school were, front row, left to right: H. Schuster, Stickney & Poor Spice Co.; G. M. Stafford, Clinton Foods, Inc.; R. F. Robinson, Battelle Memorial Institute; N. Cole, General Foods Corp.; R. L. LaBelle, N. Y. Agricultural Station. Rear row, left to right: W. S. Young, The Foxboro Co.; J. Anderson, H. J. Heinz Co.; E. Krabbe, Miller Brewing Co.; W. C. Godfrey, Campbell Soup Co.; C. B. Smith, Ralston Purina Co.; and L. M. Richardson, The Foxboro Co. Not present when photo was taken: L. H. Cole, The Quaker Maid Co.

. . . *building up and branching out*

Sales of Chas. Pfizer & Co., Inc., in 1954 reached $145,238,625, highest in the firm's history and a gain of 14% over 1953's $127,002,576. Net earnings were a record $15,200,871, equivalent after payment of preferred dividends to $2.95 per share of common stock. This compared with earnings of $14,159,604, equal to $2.73 per share in 1953. President John E. McKeen attributed the fifth consecutive annual sales increase to further expansion and diversification of the product line. Pfizer, he said, strengthened its position as the world's largest producer of antibiotics, made important advances in the fields of human and animal health and nutrition, and developed new applications for its long-established line of fine chemicals. The company's 1954 research expenditures totaled in excess of $6,000,000.

◆ ◆ ◆

Plans for construction of a $200,000 warehouse and sales office building in Chicago on property in the 4700 block of W. Augusta Blvd. have been announced by A. E. Staley Mfg. Co., Decatur, Ill. The 30,000-square-foot warehouse will be used, beginning October 1955, for Chicago area distribution of Staley starches, syrups, grocery products, and vegetable oils. The firm for some years has leased warehouse and office space in Chicago.

◆ ◆ ◆

A program for accelerating expansion of the industrial applications of its fibers in non-woven fabrics, low pressure laminates, air and liquid filters, accoustical and heat insulation, and special batting products has been launched by Celanese Corporation of America, 180 Madison Ave., New York City. In support of the industrial fibers program, a pilot plant is being erected at the Burlington, N. C., spun yarn plant to evaluate, produce, and supply data for processes for fibers in various non-woven constructions.

◆ ◆ ◆

"The Grocer and the Canny Dragon," a full-color, animated motion picture depicting successful canned foods merchandising practices, is offered by Continen-

(Continued on page 52)

Don't Guess

ABOUT FLAVORS!

This is an excellent time to remind you again that P & S takes the guesswork out of flavors. P & S, with long years of experience, offers a solid foundation on which to base the new product you are considering or an improvement of your present line now on the market. Your problems can be solved with the broad experience which P & S flavor experts apply to every aspect . . . every angle of flavor selection.

■

Consult P & S flavor experts at
BOOTH 7-8
I.F.T. CONVENTION

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Plants: Teterboro & Guttenberg, N. J.; Culver City, Calif.; New York, N. Y.

Advertisers' Index

	Page
Abbott Laboratories	3
American Can Company	35
Ass'n of American Soap & Glycerine Producers, Inc.	11
Bausch & Lomb Optical Company	39
Distillation Products Industries	14 and 15
Dodge & Olcott, Inc.	13
Eastman Chemical Products, Inc.	31
Firmenich, Inc.	41
Florasynth Laboratories, Inc.	47
Food Development Laboratory	54
Food Machinery & Chemical Corp.	37
Food Research Laboratories, Inc.	54
Fritzsche Brothers, Inc.	27
Givaudan Flavors, Inc.	17
Griffith Laboratories, Inc.	19
Hoffmann-La Roche, Inc.	4
Huron Milling Company	49
H. Kohnstamm & Company, Inc.	29
Labline, Inc.	40
LaWall & Harrisson	54
Magnus, Mabee & Reynard, Inc.	34
Morton Salt Company	45
Mutual Citrus Products Company	23
National Aniline Division	9
The Nestle Company	7
Niagara Blower Company	42
Norda Essential Oil & Chemical Co.	4th Cover
The Pfaudler Company	1
Chas. Pfizer & Company, Inc.	2nd Cover
Polak's Frutal Works	36
Polak & Schwarz, Inc.	51
F. Ritter & Company	48
Schwarz Laboratories, Inc.	54
A. E. Staley Mfg. Co.	53
Wm. J. Stange Company	24 and 25
Sterwin Chemicals, Inc.	33
Sunkist Growers, Inc.	21 and 38
Takamine Laboratory, Inc.	3rd Cover
Truesdail Laboratories, Inc.	54
S. Twitchell Company	46
Ungerer & Company, Inc.	28
Universal Oil Products Company	5
van Ameringen-Haebler, Inc.	43
Wisconsin Alumni Research Foundation	54

FOOD INDUSTRY TOPICS

(Continued from page 50)

tal Can Company for free showing to grocer and canner groups. Full of proven suggestions to increase canned foods volume at the retail level, the 15-minute, 16mm film illustrates many of the methods successfully being used by supermarket operators to "up" canned foods turnover. Food retailer and canner groups interested in screening the film should contact Sales Promotion Dept., Continental Can Co., 100 E. 42nd St., New York 17, N. Y.

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Mr. Fred B. Jacobson, industrial sanitation expert and entomologist and a member of the IFT Executive Committee, has been appointed director of Industrial Sanitation Consultants, a new division of Vogel-Ritt, Inc., with headquarters in Philadelphia at 2212 Chestnut St. The new division will offer its services to industries throughout the country.

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A new Atlas Powder Company food emulsifier plant, considered the world's largest, went into production at Memphis, Tenn., early in March. Simultaneously, Atlas announced development and manufacture of new high mono content food emulsifiers. These are mixtures of mono- and de-glycerides balanced to have high mono content, plus an optimum diglyceride content to give better dispersion and overall economy and performance of the emulsifiers in various food products. The products improve the eating quality, appetizing nature, and attractiveness of many foods.

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Nearing completion and scheduled for early opening is the new manufacturing plant of The Griffith Laboratories in Monterrey, N. L., Mexico. Located at 15 de Mayo Pte, it will go into production under the name of Laboratorios Griffith de Mexico S. A., and will offer its products for the present to customers in Mexico only.

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The Canning Machinery Division of Food Machinery and Chemical Corp., San Jose 8, Calif., has announced opening of new and enlarged branch office facilities at 925 N. E. Everett St., Portland, Ore. The FMC branch occupies office and shop space in excess of 10,500 square feet, almost double previous capacity, and combines production, manufacturing, engineering, and sales under direction of Mr. Bert Van Slyck, manager. Its application engineers will serve customers in application of equipment and in plant design, and its service engineers will assist users in operation of FMC equipment.

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To provide better facilities for servicing its increasing accounts in and around Montreal, Canada, Fritzsche Brothers of Canada, Ltd., has opened a new Canadian office at 6999 Cote des Neiges Road, corner of Numur Road, Montreal 26. Representative Ralph Arsenault, already well known in the trade, will be in charge.

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Some 315 employees, representing 204 companies in 33 states and 9 foreign countries, were graduated from Minneapolis-Honeywell's Industrial Division Training School in Philadelphia in 1954, according to Mr. M. J. Ladden, school director. Courses covered application of electric, pneumatic, and electronic automatic recording, measuring, and controlling instruments, including their repair and maintenance, and lasted from 2 to 6 weeks. Last year the school graduated the 4,000th student since it began in 1935.

Honeywell's Industrial Division also announces a new handbook-type bulletin on pneumatic control and transmission systems. It describes pneumatic controllers, their applications, and how they work. Bulletin 1120 also describes pneumatic transmission systems and cascade, ratio, and other interconnected control systems. Write Mr. W. A. Lang, Minneapolis-Honeywell Regulator Co., Industrial Division, Wayne and Windrim Aves., Philadelphia 44, Pa.

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As part of a rapidly expanding program of nuclear energy research for industry, Battelle Institute of Columbus, O., is installing one of the country's largest gamma-radiation sources. It is expected to play an important role in furthering progress on the radiation sterilization of certain foods, drugs, and medical supplies which are difficult, too costly, or impossible to sterilize by conventional methods. Initially, the source

will consist of 2,000 curies of cobalt-60, equivalent in radioactivity to $24,000,000 worth of radium. The housing for the installation has a planned capacity for 10,000 curies of the powerful atomic energy by-product. Completely owned by Battelle, the initial cobalt-60 source was made generally available to industry for contract studies on February 15.

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The Lower Wabash River Valley in southwestern Indiana and southeastern Illinois is recommended as an excellent area for the "successful establishment" of food industries in a new comprehensive study of the area's industrial potentialities made by the Chicago & Eastern Illinois Railroad. The 460-page report, most detailed of its kind ever undertaken in the area, points to particular opportunities for industries producing prepared meats, sugar, chocolate and cocoa, and oleomargarine. The factors studied in the survey include transportation, mineral resources, housing, public utilities, market and external supply sources, population and labor force, forests, and agriculture. The survey indicates local markets for various types of products, as well as opportunities for national markets. Because existing industries in the area constitute possible suppliers, markets, and competition for potential new industries, the survey also lists and classifies 8,701 business concerns in selected industries.

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Celanese Corporation of America, in support of expanding markets for its fibers in apparel, household, and industrial applications, will shortly establish new development laboratories at Charlotte, N. C., which will serve as a link between fiber research at the Summit, N. J., laboratories and commercial production at fiber plants. A 114-acre site of land, 2 miles from the present headquarters of the Textile Division, has been acquired for the erection of the facilities. The first section of the building is expected to be in operation before the end of 1955.

. . . *the human element*

Dr. Henry B. Hass, president of the Sugar Research Foundation, will receive the 1955 Honor Scroll of the New York Chapter of the American Institute of Chemists at the annual meeting, June 2, Hotel Commodore. Best known for his work in aliphatic nitration, Dr. Hass has also done extensive research in activated carbon, chlorination, fluorocarbons, and compounds of pharmacological interest.

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Mr. Robert B. Magnus, Jr., son of Vice President Robert B. Magnus, was elected assistant treasurer of the company at a meeting of the Magnus, Mabee & Reynard board in New York City on February 3. Mr. Magnus, with MM&R since 1950, graduated from Nichols Junior College, Dudley, Mass., and attended Johns Hopkins University, Baltimore.

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Arnold O. Beckman, Inc., Los Angeles, Calif., announces advancement of **Mr. S. C. Danforth** to sales promotion manager. He will have charge of the planning and preparation of operating manuals and similar technical data for the various Beckman products.

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Mr. Kenneth R. Brown, vice president of Atlas Powder Co., Wilmington, Del., was presented with the 1955 honor award of the Commercial Chemical Development Assn. at a dinner in his honor at the Hotel Statler, New York City, on March 17. The award, presented annually for outstanding achievement in the field of commercial

(Continued on page 54)

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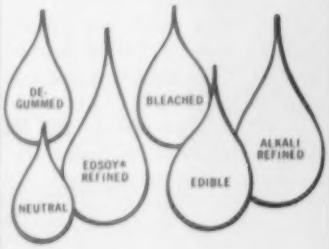

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FOOD INDUSTRY TOPICS

(Continued from page 49)

chemical development, recognized Mr. Brown's pioneering work in developing and marketing sorbitol and related products. This chemical, which Atlas manufactures from sugar, was a test tube curiosity when Mr. Brown began his work several decades ago. Today it is sold in tank car quantities totaling millions of pounds per year.

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Mr. H. R. Roberts has been appointed to Huron Milling Company's Central Southern Division to handle sales of Velvet Rainbow Starch, it was announced by Mr. Glenn H. Freeman, director of sales, specialty products. Mr. Roberts will make his headquarters in Jasper, Ala., operating under Mr. W. R. Monro, division manager.

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To implement a planned enlargement of its editorial coverage of food processing and manufacturing, IFT member **J. L. (Larry) Heid** has joined the Miller Freeman headquarters in San Francisco as editor of *Western Canner and Packer*. **Mr. Chas. R. Jacobs** has been named to the newly created post of managing editor.

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Mr. Dunbar L. Shanklin, IFT member and assistant director of research for the Dewey and Almy Chemical Co., division of W. R. Grace & Co., is attending the 27th session of the Advanced Management Program, Harvard Graduate School of Business Administration.

EMPLOYMENT NOTICES

AVAILABLE: Food Technologist, Ph.D. June '55, with Biochem. and Hort. minors. M.S. in Chemistry. Supporting field Bacteriology. Desires responsible position in Research, Plant Manager, Quality Control or Chemist. 6 yrs. of practical experience with food industry. Publications. Location immaterial. REPLY BOX 405, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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AVAILABLE: Food Chemist, B.S., '49 Grad., 6 yrs. exper. manufacturing and product development in preserving and dry mix field. Presently employed as Chief Chemist and Asst. Supt. Technical sales or similar to present position. 29 yrs. old, married. Salary open. REPLY BOX 404, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

POSITIONS OPEN: Research and Teaching Assistantships in Food Chemistry and Nutrition. Stipends ranging from $1200 to $2200 and tuition. Carry 10 to 12 units a semester toward M.S. or Ph.D. Research may be used for thesis. Begin July or September, 1955. WRITE: Head, Dept. of Food and Nutrition, Florida State University, Tallahassee, Florida.

POSITION WANTED: Technical sales, liaison, research. Ph.D. with 17 yrs. experience in chemistry and bio-chemistry. Outstanding personal and professional record. Top level position only. REPLY BOX 407, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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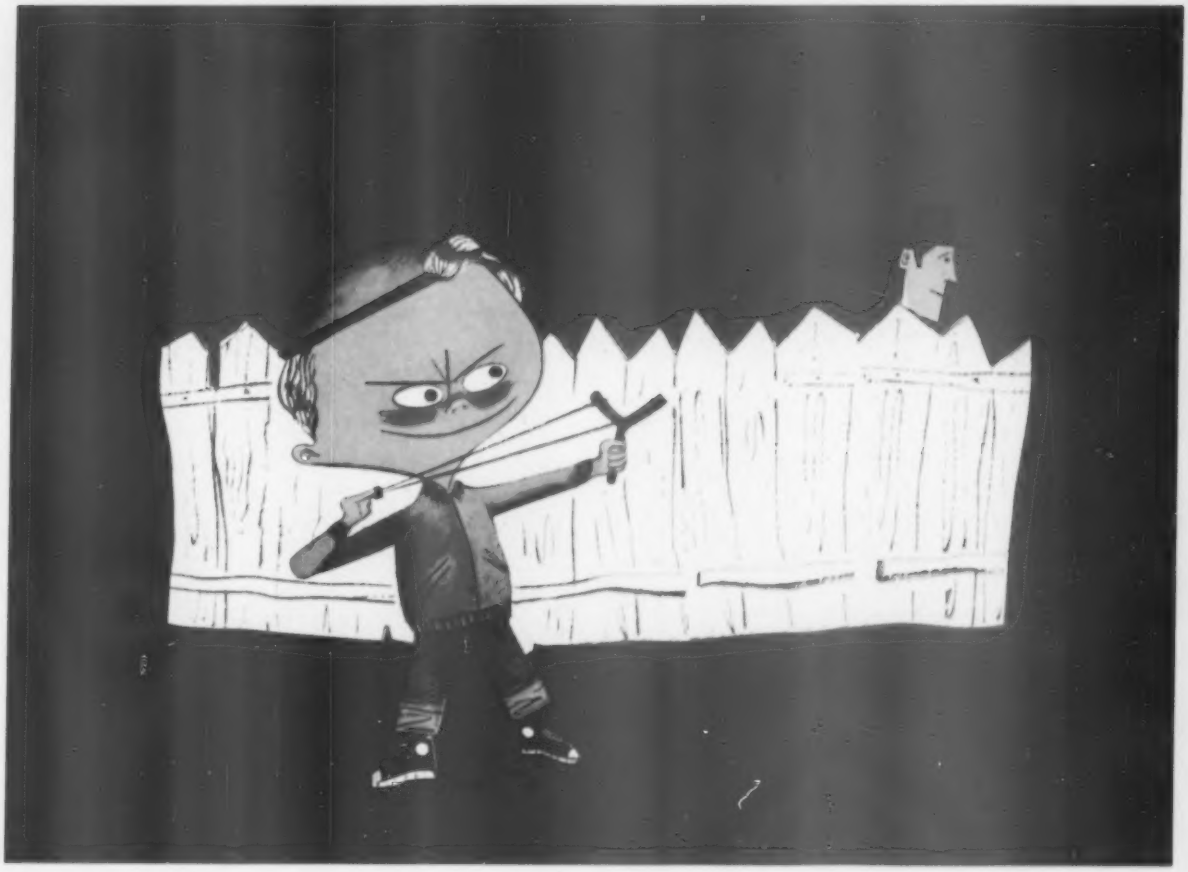

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